Phys 06, Fa 25, LACC R. Erickson   110/110   **Test 4** Ch 10-11   Name KEY

This test is closed book except for the notes provided, Show enough work for FULL credit. Attach extra white paper as needed - just indicate such. Each problem is 5 points unless otherwise noted. Multiple choice questions require a breif justification.

Chpt 10 Fluids

5

1) Substance A has a density of $3\ g/cm^3$ and substance B has a density of $4\ g/cm^3$. In order to obtain equal masses of these two substances, what must be the ratio of the volume of A to the volume of B?

A) $\frac{V_A}{V_B} = \frac{3}{4}$ B) $\frac{V_A}{V_B} = \frac{4}{3}$ C) $\frac{V_A}{V_B} = \frac{1}{3}$ D) $\frac{V_A}{V_B} = \frac{3}{1}$ E) $\frac{V_A}{V_B} = \sqrt{\frac{3}{4}}$

$\frac{m_A = \rho_A V_A}{m_B = \rho_B V_B}$ $\frac{m_A}{m_B} = \frac{\rho_A}{\rho_B} \cdot \frac{V_A}{V_B} \Rightarrow 1 = \frac{3}{4}\frac{V_A}{V_B} \Rightarrow \boxed{\frac{4}{3} = \frac{V_A}{V_B}}$

5

2) A hollow sphere of negligible mass and radius R is completely filled with a liquid so that its density is ρ. You now enlarge the sphere so its radius is $2R$ and completely fill it with the same liquid. What is the density of the enlarged sphere?

A) ρ B) 8ρ C) $\rho/2$ D) $\rho/8$ E) 4ρ

volume can change, ρ is fixed

5

3) A waiter fills your water glass with ice water (containing many ice cubes) such that the liquid water is perfectly level with the rim of the glass. As the ice melts,

A) the liquid water level rises, causing water to run down the outside of the glass.
B) the liquid–water level decreases.
C) the liquid–water level remains flush with the rim of the glass.

the weight of water displaced is the weight of the ice. Then as it melts the displaced water is filled with the ice water filling in.

5

4) A spherical ball of lead (density $11.3\ g/cm^3$) is placed in a tub of mercury (density $13.6\ g/cm^3$). Which answer best describes the result?

A) The lead ball will float with about 17% of its volume above the surface of the mercury.
B) The lead ball will float with about 83% of its volume above the surface of the mercury.
C) The lead ball will float with its top exactly even with the surface of the mercury. ← only if density
D) The lead will sink to the bottom of the mercury.

$\frac{V_{displaced\ fluid}}{V_{object}} = \frac{\rho_{obj}}{\rho_{fluid}} \rightarrow \frac{V_{disc.}}{V_{obj}} = \frac{11.3}{13.6} = 0.83 \Rightarrow \boxed{V_{displaced} = 0.83 V_{obj}}$ below

so $1.00 - 0.83 = 0.17$ above

5

5) A wooden block contains some nails so that its density is exactly equal to that of water. If it is placed in a tank of water and released from rest when it is completely submerged, it will

A) remain where it is released. B) sink to the bottom. C) rise to the surface.

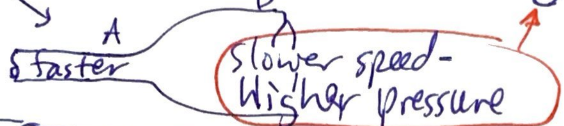
If same density so no buoyancy

(6) Water flows through a pipe. The diameter of the pipe at point B is larger than at point A. Where is the water pressure greatest?

A) at point A   B) at point B   C) It is the same.

higher speed-lower pressure

5



(7) The Tonga Trench in the Pacific Ocean is 36,000 feet deep. Assuming that sea water has an average density of $1.04\ g/cm^3$, calculate the absolute (total) pressure at the bottom of the trench in atmospheres. (1.00 in = 2.54 cm, 1.00 atm = 1.01×10^5 Pa)

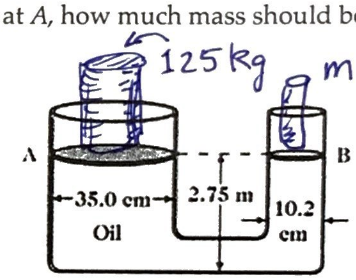
5

$P_{TOT} = P_{atm} + \rho g h$

$= [1.01 \times 10^5\ Pa] + \left(1.04 \frac{g}{cm^3}\right)\left(\frac{1\ kg}{1000\ gm}\right)\left(9.8 \frac{m}{s^2}\right)(36{,}000\ ft)\left(\frac{12\ in}{ft}\right)\left(\frac{100\ cm}{1\ m}\right)^3\left(\frac{2.54\ cm}{1\ in}\right)\left(\frac{1\ m}{100\ cm}\right)$

$= 1.01 \times 10^5\ Pa + 1118.3 \times 10^5\ Pa = 1\ atm + 1.1\ katm = 1.2\ katm$

(8) A container consists of two vertical cylindrical columns of different diameter connected by a narrow horizontal section, as shown in the figure. The open faces of the two columns are closed by very light plates that can move up and down without friction. The tube diameter at *A* is 35.0 cm and at *B* it is 10.2 cm. This container is filled with oil of density $0.820\ g/cm^3$. If a 125-kg object is placed on the larger plate at *A*, how much mass should be placed on the smaller plate at *B* to balance it?



5

$P_A = P_B$

$\frac{F_A}{A_A} = \frac{F_B}{A_B}$

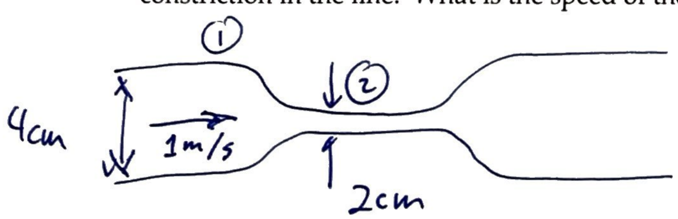
$\frac{m_A g}{\pi R_A^2} = \frac{m_B g}{\pi R_B^2}$

$m_B = \left(\frac{R_B}{R_A}\right)^2 m_A$

$= \left(\frac{10.2/2}{35.0/2}\right)^2 (125\ kg)$

$\rightarrow$ 10.6 kg

(9) Ideal incompressible fluid flows through a 4.0-cm-diameter pipe at 1.0 m/s. There is a 2.0 cm diameter constriction in the line. What is the speed of the fluid in this constriction?



$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

continuity eqn {consv. of mass}

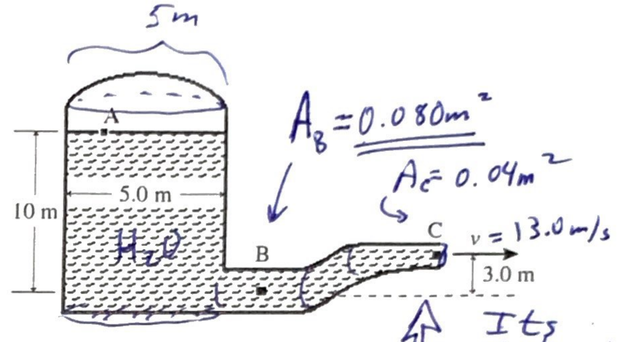
5

$v_2 = \left(\frac{A_1 v_1}{A_2}\right) = \frac{\pi (4/2)^2}{\pi (2/2)^2}(1.0\ m/s) = \left(\frac{4}{2}\right)^2 (1.0\ m/s) = 4.0\ m/s$

20

10) (10 pts) A pressurized cylindrical tank, 5.0 m in diameter, contains water that emerges from the pipe at point C with a speed of 13 m/s as shown in the figure. Point A is 10 m above point B and point C is 3.0 m above point B. The area of the pipe at point B is 0.080 m^2 and the pipe narrows to an area of 0.040 m^2 at point C. Assume that the water is an ideal fluid in laminar flow. The density of water is 1000 kg/m^3 The mass flow rate in the pipe is ?

$$\frac{\Delta m}{\Delta t} = \frac{\Delta \rho V}{\Delta t} = \frac{\rho \cdot A \cdot \Delta l}{\Delta t} = \rho A v$$



$$= \left(1000 \frac{kg}{m^3}\right)\left(0.04 m^2\right)\left(13.0 m/s\right)$$

$$= 520 \text{ kg/sec}$$

10

{sort of a trick question}

Ch 11 Oscillations

11) If we double the frequency of a system undergoing simple harmonic motion, which of the following statements about that system are true? (There could be more than one correct choice.)

A) The period is reduced to one-half of what it was.
B) The period is doubled.
C) The amplitude is doubled.
D) The angular frequency is doubled.
E) The angular frequency is reduced to one-half of what it was.

5

- $f_0 = \frac{1}{T_0}$ so $T = \frac{1}{f}$ so $2 * f_0 \Rightarrow T_{new} = \frac{1}{2f_0} = \frac{1}{2}\left(\frac{1}{f_0}\right)$
- $\omega_0 = 2\pi^r/cycle\ f_0 \frac{cyc}{sec}$

15

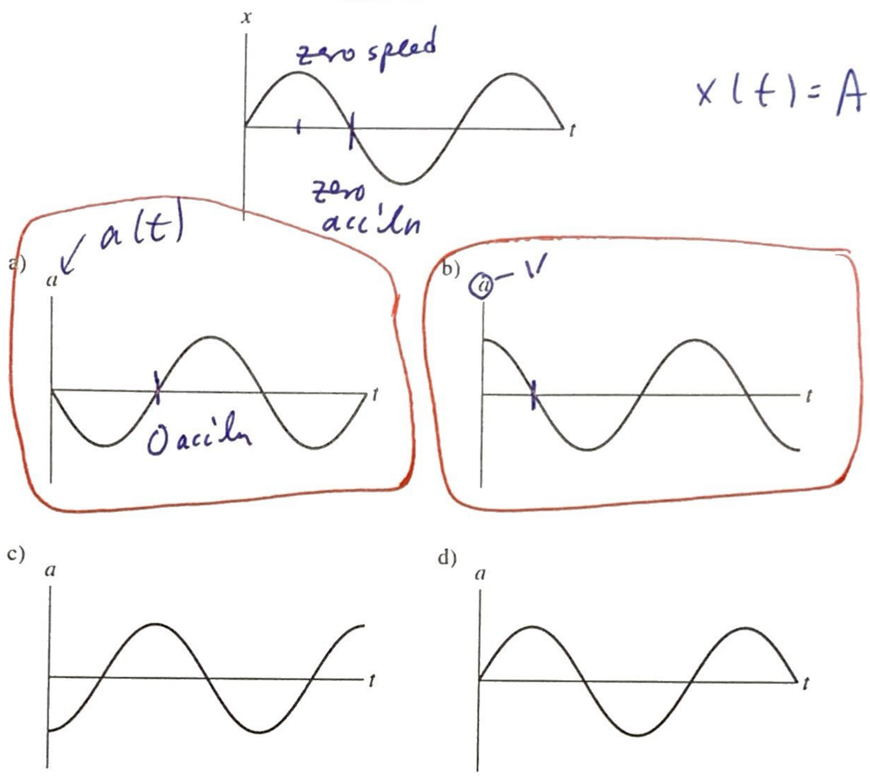
(12) The figure shows a graph of the position x as a function of time t for a system undergoing simple harmonic motion. (a) Which one of the following graphs represents the velocity of this system as a function of time?

- plot: __b__ Write down a generic eqn for v(t): $2\pi f A \cos(2\pi f t)$

(b) Which one of the following graphs represents the acceleration of this system as a function of time?

- plot: __a__ Write down a generic eqn for a(t): $-(2\pi f)^2 A \sin(2\pi f t)$

$x(t) = A \sin(\overbrace{2\pi f}^{\omega} t)$



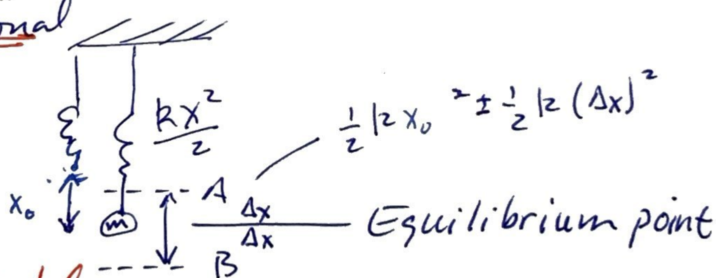
5

(13) An object is attached to a vertical spring and bobs up and down between points A and B. Where is the object located when its elastic potential energy is a minimum?

A) midway between A and B ← if horizontal
B) at either A or B
C) one–third of the way between A and B
D) one–fourth of the way between A and B
E) at none of the above points

will accept either

5



Not a well stated problem

(14) A string of mass m is under tension, and the speed of a wave in the string is v. What will be the speed of a wave in the string if the mass of the string is increased to $2m$ but with no change in the length or tension?

A) $v/2$ B) $v/\sqrt{2}$ C) $v\sqrt{2}$ D) $4v$ E) $2v$

$$V_0 = \sqrt{\frac{F_T}{\mu_0}} = \sqrt{\frac{F_T}{m_0/\ell}} \Rightarrow \sqrt{\frac{F_T}{2m_0/\ell}} = \sqrt{\frac{1}{2}}V_0 = \frac{\sqrt{2}}{2}V_0$$

5

15

15) The intensity of the waves from a point source at a distance d from the source is I. What is the intensity at a distance $2d$ from the source?

A) $I/2$ B) $I/\sqrt{2}$ C) $4I$ D) $I/4$ E) $2I$

5

$I \propto \frac{1}{r^2}$ $I_1 = K/r_1^2$, $I_2 = K/r_2^2$ $\Rightarrow \frac{I_1}{I_2} = \left(\frac{r_2}{r_1}\right)^2 \Rightarrow I_2 = \left(\frac{r_1}{r_2}\right)^2 I_1 = \frac{1}{4} I_1$

5

16) A stretched string is observed to have four equal segments in a standing wave driven at a frequency of 480 Hz. What driving frequency will set up a standing wave with five equal segments?

$n=1$ $n=2$ $n=3$ $n=4$ $\lambda = l/2$

$f_4 = 4 f_1$
$480 = 4 \cdot f_1$
$f_1 = 120\ Hz$
so $f_5 = 5 f_1 = 5(120\ Hz) = 600\ Hz$

17) If the frequency of a system undergoing simple harmonic motion doubles, by what factor does the maximum value of acceleration change?

A) 2 B) 4 C) $\sqrt{2}$ D) $2/\pi$

5

$a_{max} = (2\pi f_0)^2 A$

$a_2 = 2\pi[(2f_0)]^2 A = 4 a_{max}$

18) The position of an object that is oscillating on an ideal spring is given by $x = (17.4\ cm) \cos[(5.46\ s^{-1})t]$. Write an expression for the acceleration of the particle as a function of time using the cosine function.

5

$x_0 = 0$ $x_1 = 17.4 \cos[5.46t]$

$a = -518.7 \cos(5.46t)$

$a = (\omega)^2 A \cos[\omega t]$
$= -(5.46)^2\, 17.4 \cos[5.46t]$

19) In a supermarket, you place a 22.3-N (around 5 lb) bag of oranges on a scale, and the scale starts to oscillate at 2.7 Hz. What is the force constant (spring constant) of the spring of the scale?

$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow f = \frac{\sqrt{k/m}}{2\pi}$

$\Rightarrow (2\pi f)^2 = k/m$

5

$m(2\pi f)^2 = k$

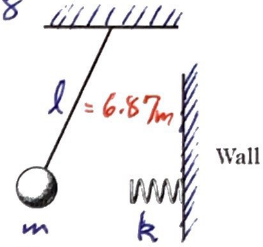
$22.3N\,(2\pi(2.7))^2 = k$

$k = 6.4\ kN/m$

25

20 (10 pts) As shown in the figure, a 0.23-kg ball is suspended from a string 6.87 m long and is pulled slightly to the left. As the ball swings through the lowest part of its motion it encounters a spring attached to the wall. The spring pushes against the ball and eventually the ball is returned to its original starting position. Find the time for one *complete* cycle of this motion if the spring constant (force constant) is 19 N/m. (Assume that once the pendulum ball hits the spring there is no effect due to the vertical movement of the ball.)

Strategy: 1/2 period of pendulum (+) 1/2 period of spring-mass



$l = 6.87\,m$, $m = 0.23\,kg$, $k = 19\,N/m$

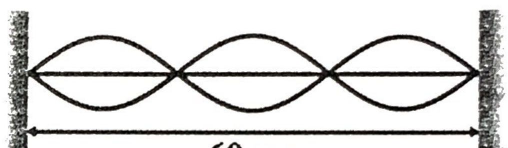
5 Reflect: $T_{pend}/2 = \dfrac{2\pi\sqrt{\dfrac{6.87\,m}{9.8\,m/s^2}}}{2} = \dfrac{5.26\,s}{2} = \boxed{2.63\,s}$

5 Reflect: $T_{sp}/2 = \dfrac{2\pi\sqrt{m/k}}{2} = 2\pi\sqrt{0.23\,kg/19\,N/m}\,/2 = \dfrac{0.69\,s}{2} = \boxed{0.36\,s}$

(+) → $\boxed{2.97\,s}$

---

21) A standing wave is oscillating at 950 Hz on a string, as shown in the figure. What is the wave speed?



$n = 3$

$V = \sqrt{\dfrac{F_T}{\mu}}$

$\lambda_3 = \dfrac{2l}{3}$

- $f_3 = 3 \cdot f_1 = \dfrac{3v}{\lambda_1}$
- $f_1 = v/\lambda_1$
- $\lambda_1 = 2l$

$\Rightarrow \dfrac{f_3 \lambda_1}{3} = v$

$V = \dfrac{(950\,Hz)(0.6\,m)2}{3}$

5 $\boxed{V = 380\,m/s}$

10