Student # : Ans Key Name: _____

Physics 101 -S101 - Midterm 1 Oct 2003

Use the back of the formula sheet for rough work

Clearly show all of your work

Use pen - or you cannot request a remark

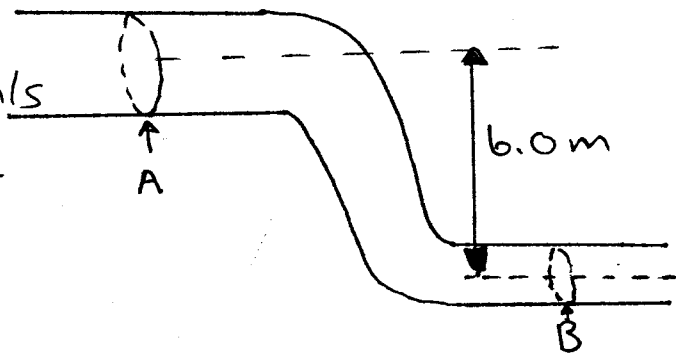
(4) **Question 1** Oil ($\rho = 800$ kg/m^3 is pumped through a pipeline. At point A its velocity is 12 m/s and the gauge pressure is 2.0×10^5 Pa. Point B is 6.0 m lower than point A and the cross-sectional area is 50% of that at point A

Eqn Continuity

$A_A v_A = A_B v_B$

$v_B = \frac{A_A}{A_B} v_A = 2 \times 12 \text{ m/s} = 24 \text{ m/s}$

B. Eqn $P_A + \frac{1}{2}\rho 12^2 + \rho g 6 = P_B + \frac{1}{2}\rho 24^2$



a) What is the velocity of the fluid at point B?

(1) 24 m/s

(3) b) What is the pressure at point B?

$P_B = P_A + 400(12^2 - 24^2) + 800 \times 9.8 \times 6 = 74240$ Pa Gauge

or 175240 Pa Abs. P.

(6) **Question 2** A steel barrel is completely filled with oil and sealed. The volume of the oil is 0.12 m^3 ($\rho = 800$ kg/m^3), the mass of the barrel is 16 kg. Neglecting the volume of the steel (it is negligible compared with the volume of oil), if the barrel is dropped in water

- will it float or sink?
- If it floats what fraction of the barrel is above the water?
- If it sinks what would be the tension in the rope necessary to pull it out of the water?

mass oil $= 0.12 \times 800 = 96$ kg

avg density $= \frac{96+16}{.12} = 933$ kg/m^3

$\therefore$ floats

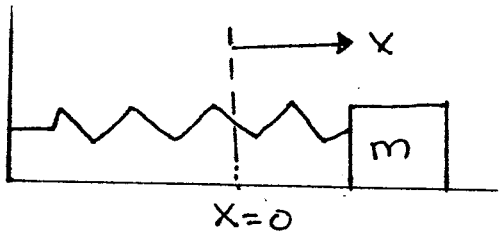
If floats $F_B = mg = \rho_f g V_f$ ← displaced

$\therefore V_f = \frac{(96+16)}{1000} = 0.112$ m^3

$\frac{\text{Vol above}}{\text{Tot Vol}} = \frac{0.12 - 0.112}{0.12} = 0.067$

$\therefore$ 6.7% above water

(10) **Question 3 A** 2.03-kg object on a horizontal frictionless surface is attached to a spring with spring constant 20.0 N/m. The object is displaced 0.500 m from equilibrium and given an initial velocity of 2.00 m/s back towards the equilibrium position.



a) At the instant the object is released what is:

i) the potential energy of the oscillating object

2 $\frac{1}{2}kx^2 = \frac{1}{2}\,20\,(0.50)^2 = 2.5\,J$

ii) the kinetic energy of the object

$\frac{1}{2}mv^2 = \frac{1}{2}\,2.03 \times 2^2 = 4.06\,J$

b) What is the frequency of oscillation?

2 $m\omega^2 = k \rightarrow \omega^2 = \frac{20}{2.03}$

$\therefore \omega = 3.14\,rad/s$ $\left(f = 0.50\,Hz \quad T = 2.0\,s.\right)$

c) What is the amplitude of oscillation?

2 $\frac{1}{2}kA^2 = (2.5 + 4.06) \rightarrow A = 0.81\,m$

d) Write an equation describing the displacement of the object as a function of time.

2 $x = 0.81m\cos(3.14t + \phi)$

$t = 0 ; x = 0.5$

$\therefore \phi = \pm 0.905\,rad$

e) Sketch the displacement of the object as a function of time

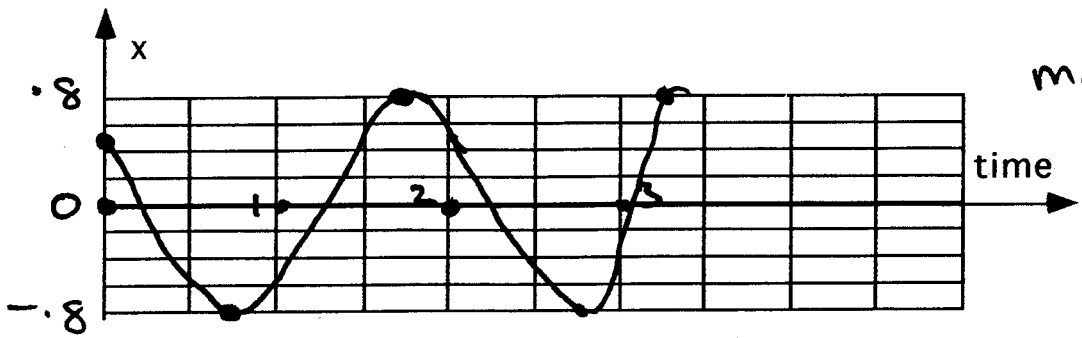
$\phi = +0.905$

$t = 0 \quad v = -\omega A \sin\phi$

v is negative

$\therefore \phi = +0.905\,rad$

2



max when

$\omega t + \phi = 2\pi$

$\therefore t = \frac{2\pi - .905}{3.14}$

$= 1.71\,s$