Physics 1B
Fall 2016
Midterm 1
10/19/16
Time Limit: 45 Minutes

Name (Print):

Teaching Assistant Wednesday 1-2pm

This exam contains 5 pages (including this cover page) and 5 problems. Check to see if any pages are missing. Enter all requested information on the top of this page, and put your initials on the top of every page, in case the pages become separated.

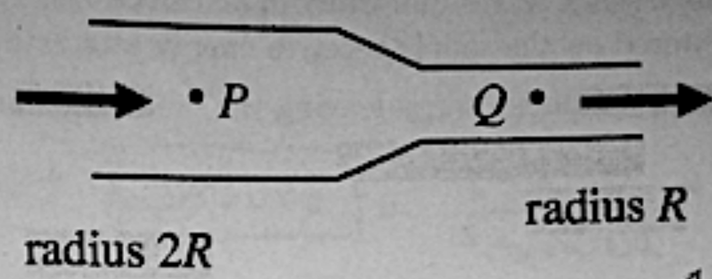
You may *not* use your books, notes, but you can use your calculator on this exam.

The following rules apply:

- **Organize your work,** in a reasonably neat and coherent way, in the space provided. Work scattered all over the page without a clear ordering will receive very little credit.
- **Mysterious or unsupported answers will not receive full credit.** A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.
- If you need more space, use the back of the pages; clearly indicate when you have done this.

Do not write in the table to the right.

Problem	Points	Score
1	10	10
2	10	10
3	10	10
4	25	22
5	25	25
Total:	80	72



same vol flow rate ⇐ Lower pressure
$A_1 v_1$ = constant
fluid speed: $\pi (2R)^2 v_P = \pi R^2 v_Q$
$4R^2 v_P = R^2 v_Q$ ⇒ $v_Q = 4 v_P$

Figure 1:

10

1. (10 points) An incompressible fluid with zero viscosity flows through a pipe of varying radius (shown in cross -section). Compared to the fluid at point P, the fluid at point Q has
   A) a greater pressure, a greater volume flow rate, and four times the fluid speed.
   B) a greater pressure, the same volume flow rate, and four times the fluid speed.
   C) the same pressure and a greater volume flow rate, and the same fluid speed.
   D) a lower pressure and the same volume flow rate, and four times the fluid speed.
   E) a lower pressure and the same volume flow rate, and one-quarter the fluid speed.

2. (10 points) In the figure, a 0.20-kg ball is suspended from a very light string 9.80 m long and is pulled slightly to the left. As the ball swings without friction through the lowest part of its motion it encounters an ideal massless 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 of the spring is 25 N/m. (Assume that once the pendulum ball hits the spring there is no effect due to the vertical movement of the ball.
   A) 3.42 s
   B) 1.71 s
   C) 0.85 s
   D) 3.60 s
   E) 1.80 s

$\frac{1}{2}T_p + \frac{1}{2}T_s$
$T_p = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{9.8}{9.8}} = 2\pi$
$T_s = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{.20}{25}} = .562$
$T = \frac{1}{2}T_p + \frac{1}{2}T_s = \pi + \frac{.562}{2} = 3.42$ s

3. (10 points) Suppose a string of length 300 (cm) is fixed at both ends. The string is then able to sustain a standing wave. If the points of the string at which the displacement amplitude is equal to 3.5 (mm) are separated by 15 (cm), find the wave length, maximum displacement amplitude. To which harmonic n, do these oscillations correspond?
   A) λ = 60 cm, A = 5.0 mm, n = 10
   B) λ = 30 cm, A = 5.0 mm, n = 8
   C) λ = 20 cm, A = 2.5 mm, n = 12
   D) λ = 15 cm, A = 2.5 mm, n =16

$4 \times 15 = \lambda = 60$
$L = n\frac{\lambda}{2} = 300$
$\Rightarrow n\frac{60}{2} = 300$
$\Rightarrow n = 10$

$A_{sw} \sin kx = y$ $x = 7.5$ cm
$.035 = A_{sw}\sin\left(\frac{2\pi}{60}(7.5)\right)$ $y = 3.5$ mm
$\Rightarrow A = 5$

4. A tiny vibrating source sends waves uniformly in all directions. An area of $3.00 cm^2$ on a sphere of radius 2.00 m centered on the source receives energy at a rate 4.50 J/s.

(a) (10 points) At what rate is energy leaving the vibrating source of the waves?

We seek J/s on the whole sphere

$4.5\ J/s \cdot \frac{4\pi(2m)^2}{.0003\ m^2} = \boxed{240000\ J/s}$ T1

$3\ cm^2 \times \frac{1\ m}{100\ cm} \times \frac{1\ m}{100\ cm} = .0003$

(b) (15 points) What is the intensity of the waves at 2.00 m from the source and at 10.0 m from the source?

$I = \frac{\text{power}}{\text{area}}$

power = energy/time

$I_2 = \frac{240000\ J/s}{4\pi(2m)^2} = \frac{240000\ J/s}{16\pi\ m^2} = \boxed{4774.65\ \frac{J/s}{m^2}}$

$\frac{I_{10}}{I_2} = \frac{R_2^2}{R_{10}^2} = \frac{(2\ m)^2}{(10\ m)^2} = \frac{4\ m^2}{100\ m^2}$

$I_{10} = \frac{4}{100} I_2 = \left(\frac{1}{25}\right)(4774.65) = \boxed{190.99\ \frac{J/s}{m^2}}$

T1

22

5. A tiny vibrating displacement $y(x,t)$ of a string stretched along the horizontal x-axis is given by $y(x,t) = (5.00\text{mm})\cos[(3.00\text{m}^{-1})\text{x} - (7.00\text{rad/s})\text{t}]$.

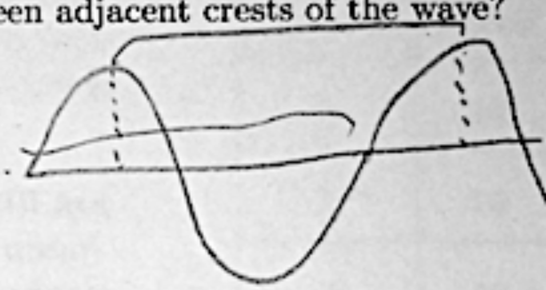
(a) (10 points) What is the minimum time for each complete cycle of the wave?

$T = \frac{2\pi}{\omega} = \frac{2\pi}{7}$ sec

or .898 sec

✓ 10

(b) (10 points) What is the distance between adjacent crests of the wave?



$k = \frac{2\pi}{\lambda} = 3.00\ m^{-1}$

$\lambda = \frac{2\pi}{3.00\ m^{-1}} = 2.094\ m$ or $= \frac{2\pi}{3}\ m$

✓ 10

(c) (5 points) How fast does the wave travel?

$v = \lambda f = \left(\frac{2\pi}{3}\ m\right)\left(\frac{7}{2\pi}\ s^{-1}\right)$

$= \frac{7}{3}\ m/s$

or $2.\overline{3}\ m/s$

✓ 5