Physics 101	Hour Exam 3	April 28, 2014

Last Name: _______________**First Name** ________________ **ID**_________________

Discussion Section:____________________**Discussion TA Name:**___________________

Instructions—Turn off your cell phone and put it away.
Calculators cannot be shared. Please keep yours on your own desk.

This is a closed book exam. You have 90 minutes to complete it.
This is a multiple choice exam. Use the bubble sheet to record your answers.

1. Use a #2 pencil; do **not** use a mechanical pencil or a pen. Fill in completely (until there is no white space visible) the circle for each intended input – both on the identification side of your answer sheet and on the side on which you mark your answers. If you decide to change an answer, erase vigorously; the scanner sometimes registers incompletely erased marks as intended answers; this can adversely affect your grade. Light marks or marks extending outside the circle may be read improperly by the scanner.

2. Print your last name in the **YOUR LAST NAME** boxes on your answer sheet and print the first letter of your first name in the **FIRST NAME INI** box. Mark (as described above) the corresponding circle below each of these letters.

3. Print your NetID in the **NETWORK ID** boxes, and then mark the corresponding circle below each of the letters or numerals. Note that there are different circles for the letter "I" and the numeral "1" and for the letter "O" and the numeral "0". **Do not** mark the hyphen circle at the bottom of any of these columns.

4. You may find the version of **this Exam Booklet at the top of page 2**. Mark the version circle in the **TEST FORM** box in the bottom right on the front side of your answer sheet. **DO THIS NOW!**

5. Stop **now** and double-check that you have bubbled-in all the information requested in 2 through 4 above and that your marks meet the criteria in 1 above. Check that you do not have more than one circle marked in any of the columns.

6. Print your UIN# in the **STUDENT NUMBER** designated spaces and mark the corresponding circles. You need not write in or mark the circles in the SECTION box.

7. Write in your course on the **COURSE LINE** and on the **SECTION** *line*, print your **DISCUSSION SECTION**. (You need not fill in the INSTRUCTOR line.)

8. Sign **(DO NOT PRINT)** your name on the **STUDENT SIGNATURE** *line*.

*Before starting work, check to make sure that your test booklet is complete. After these instructions, you should have **9** **numbered pages** plus 2 Formula Sheets.*

On the test booklet:
Write your **NAME**, your **Discussion TA's NAME**, your **DISCUSSION SECTION** and your **NETWORK-ID**. Also, write your **EXAM ROOM** and **SEAT NUMBER**.

When you are finished, you must <u>hand in BOTH the exam booklet AND the answer sheet</u>. Your exam will not be graded unless both are present.

<u>Academic Integrity</u>—**Giving assistance to or receiving assistance from another student or using unauthorized materials during a University Examination can be grounds for disciplinary action, up to and including expulsion.**

This Exam Booklet is Version A. Mark the **A** circle in the **TEST FORM** box in the bottom right on the front side of your answer sheet. **DO THIS NOW!**

Exam Format & Instructions:

This exam is a mixture of :
* Three-Answer Multiple Choice (3 points each)
* Five-Answer Multiple Choice (6 points each)

There are 25 problems for a maximum possible raw score of **99** points.

Instructions for Three-Answer Multiple Choice Problems:
Indicate on the answer sheet the correct answer to the question (*a, b* or *c*).
Each question is worth 3 points. If you mark the wrong answer, or mark more than one answer, you receive 0 points.

Instructions for Five-Answer Multiple Choice Problems:
Indicate on the answer sheet the correct answer to each question (*a, b, c, d* or *e*).
Credit is awarded in the following way:
- If you mark one answer and it is correct, you will receive 6 points;
- If you mark two answers, and one of them is correct, you will receive 3 points;
- If you mark three answers and one of them is correct, you will receive 2 points.
- If you mark no answer or more than three answers, you will receive 0 points.

Check to make sure that you bubble in ALL of your answers on the scantron (answer sheet).
Only what is marked on your scantron/answer sheet will count!

The next three questions pertain to the situation described below.

A block of mass $m = 4.1\ kg$ is hanging from a spring with spring constant $k = 31.5\ N/m$. The block is initially at rest. It is lifted a distance of $0.169\ m$ and released, after which it oscillates up and down.

1) What is the angular frequency, ω, of the oscillations?

(a.) $\omega = 2.77\ rad/s$
b. $\omega = 0.722\ rad/s$
c. $\omega = 1.8\ rad/s$
d. $\omega = 5.54\ rad/s$
e. $\omega = 0.361\ rad/s$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{31.5\ N/m}{4.1\ Kg}} = 2.77\ rad/sec$$

2) What is the maximum velocity, v_{max} of the block as it oscillates?

a. $v_{max} = 0.061\ m/s$
b. $v_{max} = 0.156\ m/s$
c. $v_{max} = 0.234\ m/s$
(d.) $v_{max} = 0.468\ m/s$
e. $v_{max} = 0.117\ m/s$

$$\frac{1}{2} m v^2 = \frac{1}{2} k A^2$$

$$v = \sqrt{\frac{kA^2}{m}} = \sqrt{\frac{31.5\ N/m \times (0.169\ m)^2}{4.1\ Kg}} = 0.468\ m/s$$

3) The block is brought to rest. It is now lifted a distance of $0.338\ m$ and released. Compared with when it was raised a distance of $0.169\ m$ and released, the angular frequency, ω, of oscillation is

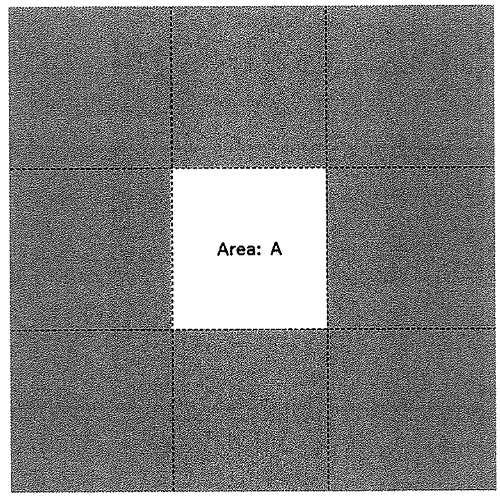
a. *increased*
(b.) *the same*
c. *decreased*

$$\omega = \sqrt{\frac{k}{m}}$$

NOT ON EXAM 3

The next two questions pertain to the situation described below.

Consider this plate of aluminum at $T_1 = 20^oC$ with a square hole as shown in the diagram. The coefficient of linear thermal expansion is $\alpha = 23.1x10^{-6} K^{-1}$.



4) When the plate is heated to $T_2 = 350^o$ the hole will

a. *get smaller*
b. *get larger*
c. *stay the same*

5) If the hole has area $A = 1.5\ cm^2$ at $T_1 = 20^oC$, what is the area of the hole at $T_2 = 350^o$? (hint: The thermal expansion coefficient for an area is $\alpha_A = 2\ \alpha$)

a. $A_{new} = 1.52\ cm^2$
b. $A_{new} = 1.55\ cm^2$
c. $A_{new} = 1.48\ cm^2$

The next two questions pertain to the situation described below.

A ball of mass $m = 3.3\ kg$ is hanging from a string of length $3.8\ m$ and oscillating as a pendulum.

6) The period, T, of oscillation is

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{3.8\ m/s^2}{9.8\ m}} = 3.91s$$

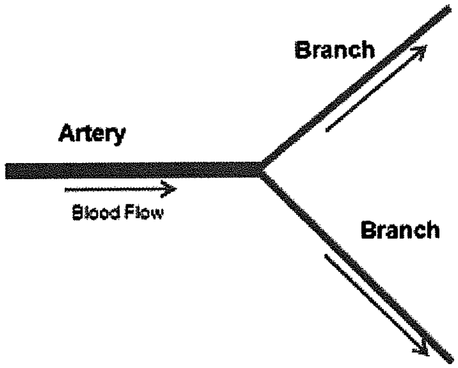
a. $T = 1.3\ s$
b. $T = 10.1\ s$
c. $T = 7.82\ s$
(d.) $T = 3.91\ s$
e. $T = 20.2\ s$

7) If the length of the pendulum remains unchanged but the mass of the ball is increased to $m = 6.6\ kg$, the period of oscillation, T, will

a. *increase by a factor of 4*
(b.) *stay the same*
c. *increase by a factor of 2*

$$T = 2\pi\sqrt{\frac{g}{L}}$$

The next three questions pertain to the situation described below.



Consider a blood artery of cross section $A = 1.7\ mm^2$. As shown above, it branches into two identical narrower arteries each of cross sectional area $A' = 0.85\ mm^2$. An equal volume of blood flows in each branch. Blood flows in the larger artery at a speed of *1.5 cm/s*.

8) At what speed does blood flow in the narrower branches?

a. $v_{branch} = 0.75\ cm/s$
b. $v_{branch} = 6\ cm/s$
c. $v_{branch} = 3\ cm/s$
(d.) $v_{branch} = 1.5\ cm/s$
e. $v_{branch} = 0.375\ cm/s$

$A_1 v_1 = A_2 v_2$

$\Rightarrow v_2 = v_1 \frac{A_1}{A_2} = 1.5\ cm/s \times \frac{1.7}{(0.85 + 0.85)}$

$= 1.5\ cm/s$

9) Now one of the branches gets clogged by cholesterol deposits allowing no flow through it. At what speed would blood flow in the other branch?

a. $v_{branch} = 6\ cm/s$
b. $v_{branch} = 1.5\ cm/s$
c. $v_{branch} = 0.375\ cm/s$
(d.) $v_{branch} = 3\ cm/s$
e. $v_{branch} = 0.75\ cm/s$

$A_1 v_1 = A_2 v_2$

$\Rightarrow v_2 = v_1 \frac{A_1}{A_2} = 1.5\ cm/s \times \frac{1.7}{0.85}$

$= 3\ cm/s$

10) The blood pressure in the open branch compares to the blood pressure in the larger artery as follows:

(a.) *Smaller*
b. *Same*
c. *Larger*

Higher v $\Rightarrow$ Smaller P

PROBLEMS 11, 12 NOT ON EXAM 3

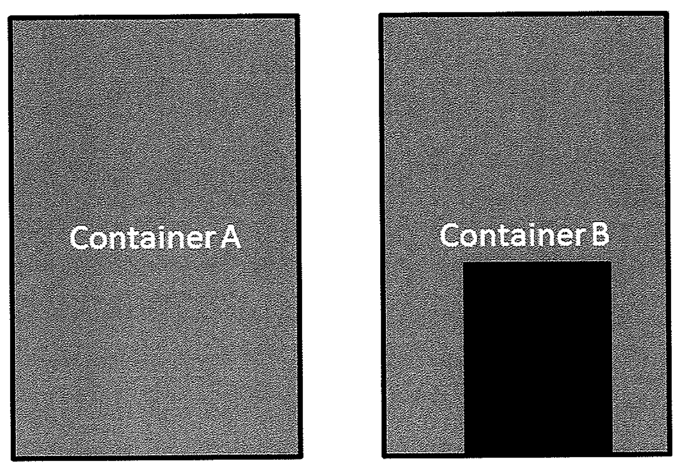
11) Race car tires operate at high temperatures. At $T_{cool} = 20^oC$ the tires are filled with $P_{cool} = 25.9\ PSI$, and put on the race car. After 5 laps, the tires reach $T_{hot} = 66.5^oC$. What is the pressure in the tires (assume the volume of the tires is constant)?

a. $P_{hot} = 22.4\ PSI$
b. $P_{hot} = 86.1\ PSI$
c. $P_{hot} = 30\ PSI$

12) A liquid has a density at *289 K* of $955\ kg/m^3$. Its (volume) thermal expansion coefficient is $1.05x10^{-3}/K$. What is its density at *316 K*?

a. $983\ kg/m^3$
b. $1050\ kg/m^3$
c. $929\ kg/m^3$
d. $1020\ kg/m^3$
e. $845\ kg/m^3$

Consider two identical containers. Container A is filled with water to the top. Container B has a block of iron which sinks to the bottom, but the level of the water is also at the top.



13) Which container weighs more?

(a.) *Container B*
b. *They both weigh the same*
c. *Container A*

14) An ice cube floats in a glass of syrup whose density is greater than that of water. What happens to the level of the liquid in the glass when the ice melts?

a. *It stays the same.*
(b) *It rises.*
c. *It falls.*

Ice displaces volume of syrup whose weight equals weight of ice. This volume is less than the volume of water created when ice melts.

The next two questions pertain to the situation described below.

A normal conversation between two people is carried out at a loudness of about *60 dB*.

15) If ten people, close together, all speak at once, the loudness will increase to about

a. *63 dB*
b. *80 dB*
(c) *70 dB*
d. *75 dB*
e. *83 dB*

$$\beta_2 - \beta_1 = 10\ dB \times \log_{10} \frac{I_2}{I_1}$$

$$\beta_2 - 60\ dB = 10\ dB \times \underbrace{\log_{10} 10}_{=1}$$

$$\beta_2 = 70\ dB$$

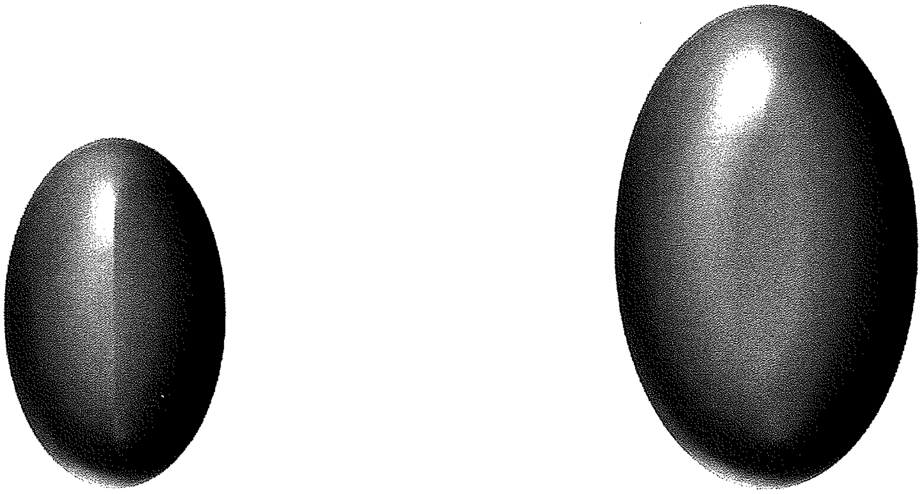
16) If the distance between two people is increased by a factor of *3*, but they continue to speak at the same intensity, the intensity of the sound that each person is exposed to decreases by a factor of

(a) *1/9*
b. *1/3*
c. *1/27*

(Not including the sound coming from themselves)

NOT ON EXAM 3

The next two questions pertain to the situation described below.



Balloon at T_1 Balloon at T_2

You fill a balloon with $V_1 = 0.00159\ m^3$ of argon gas (*molar mass = 40 amu*) at $T_1 = 20^oC$. You heat the gas in the balloon, keeping the pressure constant.

17) At $T_2 = 31.5^oC$, what is the volume of the gas in the balloon?

a. $V_2 = 0.0025\ m^3$
b. $V_2 = 0.00165\ m^3$
c. $V_2 = 0.00153\ m^3$

18) At $T_2 = 31.5^oC$, what is the RMS speed, v_{RMS}, of the argon atoms in the balloon? ($1\ amu = 1.66x10^{-27}\ kg$)

a. $v_{RMS} = 140\ m/s$
b. $v_{RMS} = 308\ m/s$
c. $v_{RMS} = 436\ m/s$

The next three questions pertain to the situation described below.

A wire of length *1.69 m* and total mass *0.033 kg* is fixed at its ends and held at tension $T = 31.5\ N$.

19) What is the velocity of a transverse wave on the wire?

a. $v = 0.0421\ m/s$
b. $v = 0.0249\ m/s$
(c.) $v = 40.2\ m/s$
d. $v = 0.784\ m/s$
e. $v = 8.04\ m/s$

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{31.5\ N}{0.033\ kg / 1.69\ m}} = 40.2\ m/s$$

20) The wire vibrates at its fundamental frequency. What is the wavelength, λ, of the wave?

(a.) $\lambda = 3.38\ m$
b. $\lambda = 1.69\ m$
c. $\lambda = 0.845\ m$

$$\lambda = 2L$$
$$= 2 \times 1.69\ m$$
$$= 3.38\ m$$

$\lambda = 2L$

21) Compared with the fundamental frequency, the wavelength of the first harmonic is

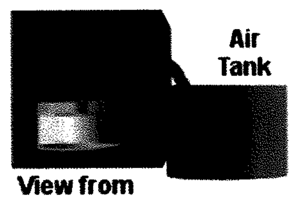
a. *decreased*
b. *increased*
(c.) *the same*

The first harmonic is the fundamental frequency.

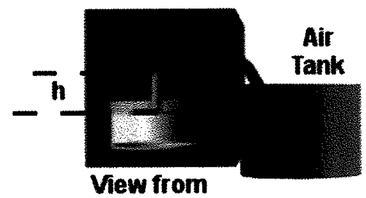
The next four questions pertain to the situation described below.

A barometer is made from an evacuated tube *($P_1=0$ Pa)* inserted into a pool of mercury *($\rho=13600$ kg/m^3)*. The barometer is placed in a sealed box connected, through a valve, to a tank of air. There are no leaks. A camera allows you to see the height of mercury in the tube as shown in the diagram.

Initial State



Final State



22) Initially, the height of mercury in the tube is $h = 0$ *mm* above the height of mercury in the pool. What does this tell you about the pressure in the box?

a. *The barometer is not working.*
(b.) *The box must have been evacuated ($P_2 = 0$ Pa).*
c. *Pascal's Principle is not true.*

23) You open the valve to the air tank for several seconds, turn off the valve, and look at the tube. The height of the mercury in the tube is $h = 755$ *mm* above the height of the pool. Now what do you know?

a. *Archimedes' Principle caused the mercury to float up the tube.*
(b.) *Because of Pascal's Principle the mercury in the tube rose in response to the change in pressure.*
c. *Bernoulli's Principle caused the mercury to flow into the tube and stop.*

24) Calculate the air pressure, P_2, in the box.

(a.) $P_2 = 101$ *kPa*
b. $P_2 = 1.77 \times 10^{-4}$ *kPa*
c. $P_2 = 10300$ *kPa*

$P_2 = P_1 + \rho g h$

$= 0 + 13600 \text{ kg/m}^3 \times 9.8 \text{ m/s}^2 \times 0.755 \text{ m}$

$= 100{,}626 \text{ Pa} = 101 \text{ kPa}$

25) You open the valve again and notice that the height of the mercury in the tube is now $h = 842$ *mm*. Typical atmospheric pressure in Urbana, IL is around $P_{atm} = 103$ *kPa*. The pressure in the box is now:

a. *less than typical atmospheric pressure.*
b. *the same as typical atmospheric pressure.*
(c.) *greater than typical atmospheric pressure.*

$P_2 = P_1 + \rho g h$

$= 0 + 13600 \text{ kg/m}^3 \times 9.8 \text{ m/s}^2 \times 0.842 \text{ m}$

$= 112{,}221 \text{ Pa} = 112 \text{ kPa}$