PHY205-H1S
"The Physics of Everyday Life"

Test 2

5pm – March 6, 2013 – **Version 4**

Solutions

Prof. Jason Harlow
Physics Department,
University of Toronto

Last Name: _____ First Name: _____.

Student Number: _____ Tutorial (circle) M6 W6 F10 F12 T.A.: _____.

This test has 5 pages and should take no longer than 50 minutes. You may use a calculator and one 8×13 cm index card with your own hand-written notes, if you wish. Assume that the acceleration due to gravity in all problems is $g = 10$ m/s^2. Unless otherwise indicated in a particular question, you may assume the density of water is 1000 kg/m^3, the speed of sound in air is 340 m/s, and air resistance is negligible.
Common Prefixes: m = "milli-" = 10^{-3} c = "centi-" = 10^{-2} k = "kilo-" = 10^{3} M = "mega-" = 10^{6}
Good luck!

Written Answer Part

Please answer the following questions. Show all your reasoning and work legibly in the blank space provided, and write your final numerical answers in the boxes provided. For final numerical answers be sure to include units, and direction if the quantity is a vector. You may use the back of the page for rough work which will not be graded.

Written A:	/4
Written B:	/4
Written C:	/4
+ 12 multiple choice worth 2 points each. Test total possible is 36.	

A. You are holding two cups of coffee. They are identical, except the coffee in cup A has an initial temperature of 70°C, and the coffee in cup B has an initial temperature of 50°C. You then take a 2 minute walk outside with these two cups of coffee, where the temperature of the environment is 0°C.

i. Which cup do you expect will lose more heat while you are walking? [circle one]
(a.) Cup A
b. Cup B
Briefly explain your answer in the box below.

Newton's Law of cooling: heat loss rate $\sim \Delta T$
$\Delta T_A = 70°$ ← cup A loses heat faster.
$\Delta T_B = 50°$

ii. The final temperature of the coffee in cup A after the 2 minute walk is 63°C. What do you expect will be the approximate final temperature of the coffee in cup B?

cup A lost 7° over 2 minutes.

$$\frac{\text{rate}_B}{\text{rate}_A} = \frac{\Delta T_B}{\Delta T_A} \approx \frac{50°}{70°} = \frac{5}{7} \text{ as fast.}$$

$7°C\left(\frac{5}{7}\right) = 5°C$ expected loss for 2 minutes for cup B.

$50° - 5° = 45°$

45°C

B. Helium gas has a density of 0.2 kg/m^3. Air has a density of 1 kg/m^3. A large balloon is filled with 5 m^3 of Helium gas. The material which makes up the balloon itself has a mass of 2 kg.

i. What is the total mass of the balloon plus all the Helium gas it contains?

Mass of Helium: $m_{He} = d_{He} \cdot V = 0.2 \frac{kg}{m^3} \cdot 5 m^3 = 1 kg$

+ Mass of the balloon itself, 2 kg.

$m_{tot} = 1 + 2 = 3 kg$

3 kg

ii. What is the buoyancy force of the air on the Helium-filled balloon?

Mass of air displaced: $m_{air} = d_{air} \cdot V = 1 \frac{kg}{m^3} \cdot 5 m^3 = 5 kg$.

F_B = weight of air displaced,

$= m_{air} \cdot g = 5 \cdot 10 = 50 N$

50 N, up.

iii. What is the net force on the Helium-filled balloon?

Total mass of balloon = 2 kg + 1 kg = 3 kg.

Weight = 3 × 10 = 30 N, down

Free-body diagram: ↑ 50 N, ↓ 30 N

$F_{Net} = 50 - 30 = 20$ up

20 N, up

C. A piano tuner has a tuning fork labeled "A", which he knows always vibrates with a frequency of 440 Hz. He holds the tuning fork next to a certain string on the piano and sounds both at once. He hears 3 beats per second.

i. From the information above only, what can the piano tuner conclude about the frequency of the string? [If a numerical value is possible, include it in the box provided.]

It is either 443 Hz or 437 Hz.

He then tightens the string slightly, and repeats the test by sounding the string and the tuning fork both at once. This time he hears 5 beats per second.

ii. From this information including the information above, what can the piano tuner conclude about the final frequency of the string? [If a numerical value is possible, include it in the box provided.]

tighter string ⇒ higher frequency.

445 Hz

Multiple Choice Part (2 points per question)
Please fill your answers in on the provided answer-sheet. Be sure to fill in the identifying information on the top of your answer sheet. You may use pen or pencil when filling in the circles. IMPORTANT: There are multiple versions of this test. On your bubble sheet, please fill in **4** for version.

1. Suppose potatoes are being sold for $1.09 per kg, but they come in a variety of sizes. You plan to take them home, remove and discard all the peels, then chop and cook them. To get the most cooked potatoes for your money,
   (A.) you should try to choose a fewer number of larger potatoes. ← smaller surface area to volume ratio. Less wasted peel.
   B. you should try to choose lots of small potatoes.
   C. it doesn't matter what sizes of potatoes you choose.

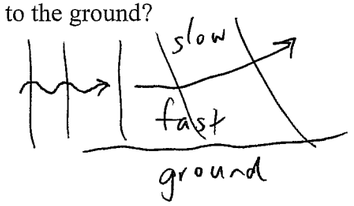
2. What causes surface tension?
   A. Archimedes' principle.
   (B.) Cohesive forces between molecules in the liquid.
   C. Viscosity of the liquid.
   D. Pressure in the liquid.
   E. Bernoulli's principle.

3. On a windy day, the air over your house must blow up and over the roof of your house. When it does this, the wind speed must increase over the roof of your house, and this can result in an upward pulling force on your roof. This is a good example of
   A. Archimedes' principle
   B. Boyle's Law
   C. Scaling
   D. Pascal's principle
   (E.) Bernoulli's principle

4. 10,000 Joules of heat are added to 1 kg of each of the following substances. Of these four, which would you expect to have the smallest change in temperature as a result of adding this heat?
   A. Iron
   (B.) Water
   C. Styrofoam
   D. Glass
   E. All of these will have the same change in temperature.

5. A police car has a siren which emits a single fixed frequency. The police car is located 10 m away from you and is driving directly away from you at a constant speed of 15 m/s. Which of the following is true about the frequency you hear?
   A. It is higher than the rest frequency, and steadily rising.
   B. It is lower than the rest frequency, and steadily decreasing.
   C. It is momentarily equal to the rest frequency, but is steadily decreasing.
   (D.) It is lower than the rest frequency, and stays constant. away → f is lower than f_o
   E. It is higher than the rest frequency, and stays constant.

6. When the speed of sound near the ground is greater than it is at higher altitudes, what tends to happen to a sound wave that is initially traveling parallel to the ground?
   A. Its amplitude tends to increase as it travels.
   B. Its frequency tends to decrease as it travels.
   C. It tends to bend its direction downward.
   (D) It tends to bend its direction upward.
   E. Its frequency tends to increase as it travels.



7. Which of the following is not a transverse wave?
   A. radio
   B. waves on a string
   (C) sound
   D. light
   E. All of the above are transverse waves.

8. A block of metal and a block of Styrofoam are sitting outside on a winter day, so they both have the same temperature of -5°C. When you touch the metal it feels very cold, but when you touch the Styrofoam it feels relatively warm. Why is this?
   A. The metal has a higher specific heat capacity than Styrofoam.
   (B) The metal has a higher thermal conductivity than Styrofoam.
   C. The metal has a lower temperature than the Styrofoam.
   D. The metal has a lower thermal conductivity than Styrofoam.
   E. The metal has a lower specific heat capacity than Styrofoam.

9. An iron bar has a temperature of 300 Kelvin, and a length of exactly 1.5 m. If you heat the iron bar, doubling its temperature to 600 Kelvin, what will happen to its length?
   A. Its length will double.
   B. Its length will not change.
   C. Its length will drop by a factor of 2.
   D. It will get slightly shorter.
   (E) It will get slightly longer.

10. Chapter 14 ends with a discussion of plasma. In this context, what is plasma?
   A. A flowing fluid which is incompressible, nonviscous and has steady streamlines.
   B. A molecular gas such as N_2 or O_2.
   C. The colorless fluid part of blood, lymph, or milk, in which corpuscles or fat globules are suspended.
   D. Anything that flows; in particular, any liquid or gas.
   (E) A fourth phase of matter, existing mainly at high temperatures, consisting of positively charged ions and free electrons.

11. Lead is more dense than aluminum, and both are more dense than water. Two blocks of identical size and shape are completely submerged underwater. One is made of lead and one is made of aluminum. Which is true?
    A. The buoyancy force of water on the aluminum block is greater than the buoyancy force of water on the lead block.
    (B) The buoyancy force of water on the two blocks is the same, and it is not zero.
    C. The water does not exert a buoyancy force on the two blocks.
    D. The buoyancy force of water on the lead block is greater than the buoyancy force of water on the aluminum block.

12. Which of the following makes an element distinct from any other element?
    A. The number of electrons orbiting the nucleus.
    (B) The number of protons in the nucleus.
    C. The total mass of the nucleus plus the orbiting electrons.
    D. The total mass of the nucleus.
    E. The number of neutrons in the nucleus.