PHY205-H1S
"The Physics of Everyday Life"

Test 2

2pm – March 6, 2013 – **Version 2**

Solutions

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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!

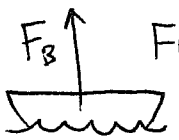
Written Answer Part

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. A boat has a total mass of 600 kg. A hole in the hull causes water to flood in, and the boat sinks to the bottom of the lake. When the boat is completely submerged it displaces 0.1 m^3 of water.

i. Before it sank, when the boat was floating on the surface of the water, what was the buoyancy force of the water on the boat?



Floating: F_B = weight of boat = mg

$= 600\text{ kg} \cdot 10\frac{m}{s^2}$

$F_B = 6000\text{ N}$

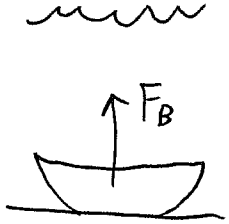
6000 N, up

ii. What is the average density of the boat?

$\text{density} = \frac{m}{V} = \frac{600\text{ kg}}{0.1\text{ m}^3} = 6000\frac{\text{kg}}{\text{m}^3}$

$6000\ \frac{\text{kg}}{\text{m}^3}$

iii. As the boat sits at the bottom of the lake, what is the buoyancy force of the water on the boat?



Submerged: F_B = weight of displaced water

$m_w = d_w \cdot V = 1000\frac{\text{kg}}{\text{m}^3} \cdot 0.1\text{ m}^3 = 100\text{ kg}$

$F_B = 100\text{ kg} \cdot 10\frac{m}{s^2} = 1000\text{ N}$

1000 N, up

B. A toy car has a length of 30 cm. It is a model of a real car which is 3 m long. For this problem assume that the toy car is the exact same shape as the real car, and is made of the same materials.

i. The toy car has a mass of 1 kg. What is the mass of the real car?

$x_{mod} = 0.3$ m $x_{real} = 3$ m $\frac{x_{real}}{x_{mod}} = \frac{3}{0.3} = 10$ times

Volume scales as x^3

$\frac{V_{real}}{V_{mod}} = \left(\frac{x_{real}}{x_{mod}}\right)^3 = 10^3 = 1000$ times.

Same density $\Rightarrow m \sim V$ $m_{real} = 1$ kg $\times 1000$

1000 kg.

ii. The toy car required 0.1 L of paint to cover its paintable surfaces. How much paint is required to paint the same surfaces on the real car? [Assume the same thickness of paint is applied to the real car as the toy car.]

Surface area scales as x^2

$\frac{A_{real}}{A_{mod}} = \left(\frac{x_{real}}{x_{mod}}\right)^2 = 100$ times.

$\Rightarrow$ 100 times more paint.

0.1 L $\times 100 = 10$ L

10 L

C. The questions below relate to a sample of ice which melts and becomes a sample of water.

i. A sample of ice has an initial temperature of −3°C. Some heat is added to the sample, and it warms up by +1°C. As a result, the density [circle one]

a. increases.
(b) decreases.
c. stays the same.

Briefly explain your answer in the box below.

Solid ice decreases in density as it heats up, like most materials.

ii. A sample of water has an initial temperature of +2°C. Some heat is added to the sample, and it warms up by +1°C. As a result, the density [circle one]

(a.) increases.
b. decreases.
c. stays the same.

Briefly explain your answer in the box below.

Unlike most materials, water has a density maximum at +4°C. Thus, as water warms from +1 to +2°C, it gets more dense.

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 **2** for version.

1. Four large springs in your car are compressed to support the weight of the car above and passengers upon the wheel base. The springs each have a length of 42 cm when they support the 800 kg of mass of the empty car above. The equilibrium length of each of these springs when they are not compressed is 50 cm. When four people get into the car, the springs now must support a mass of 1000 kg. What is the approximate length of each of the springs when supporting the full car?
   A. 10 cm
   B. 42 cm
   C. 50 cm
   D. 44 cm
   (E.) 40 cm

Empty car: ..... 50 cm, ---- 42 cm, $\Delta x = 8$ cm, $F = 800\,kg \cdot g$

Hooke's Law: $F \sim \Delta x$

Full car: $F = 1000\,kg \cdot g \Rightarrow \Delta x = 10$ cm

$\Rightarrow$ Length $= 50 - 10 = 40$ cm

2. Which of the following is in a plasma state?
   (A.) A torch flame
   B. Helium gas
   C. Molten lava
   D. Liquid hydrogen
   E. Dry ice

3. You notice that the temperature of a substance goes up very quickly when you put it on a hot plate. From this observation, what can you say about this substance?
   A. It has a high specific heat capacity.
   B. It has a high thermal conductivity.
   C. It has a high thermal density.
   D. It has a low thermal conductivity.
   (E.) It has a low specific heat capacity.

4. In July in Toronto the average daily maximum temperature is 26°C. For comfort, you like to keep your electric air conditioning running while you are in the house, and you set the thermostat to 22°C. You will be going on a trip for 2 days and you wish to save as much as possible on your electricity bill at the end of the month. Which of the following is the best way to save money on electricity?
   A. Turn your thermostat down to about 20°C while you are away.
   (B.) Turn off your air conditioning while you are away.
   C. Keep your thermostat set to 22°C while you are away.
   D. Turn your thermostat up to about 24°C while you are away.

5. An antique clock is driven by a swinging pendulum, which is a metal mass hanging at the bottom of a long metal rod. At room temperature, the pendulum swings back and forth with a period of exactly one second, and the clock keeps good time. If the temperature of the room and all its contents rises to +40°C on a very hot day, how will this affect the clock?
   (A) The clock will run slow.
   B. The clock will run fast.
   C. The clock will not be affected.

longer pendulum
⇒ longer period
⇒ slower clock

6. Which of the following affects the speed of sound in air?
   (A) Air temperature
   B. Frequency
   C. Speed of the sound source
   D. Pitch
   E. Amplitude

7. What is the approximate range of human hearing ?
   A. 0.2 Hz to 200 Hz
   B. 2 kHz to 2000 MHz
   C. 2000 MHz to 20,000 MHz
   (D) 20 Hz to 20,000 Hz
   E. 2 Hz to 2000 Hz

8. Radio waves travel at the speed of light, 300,000 km/s. What is the wavelength of a radio wave with a frequency of 100 megahertz?
   A. 0.3 m
   B. 30 m
   C. 3×10^{16} m/s
   D. 300 m
   (E) 3.0 m

$v = f\lambda$

$\lambda = \frac{v}{f} = \frac{300{,}000 \times 10^3 \text{ m/s}}{100 \times 10^6 \text{ Hz}}$.

$\lambda = \frac{3 \times 10^8 \text{ m s}^{-1}}{10^8 \text{ s}^{-1}} = 3 \text{ m}$

9. You are trying to choose between two cars that are identical in model and price, but one is painted black and one is painted white. Compared to the black car, the white car
   A. is better at absorbing heat from sunlight during the day, and better at radiating away heat during the night.
   B. is not as good at absorbing heat from sunlight during the day, but better at radiating away heat during the night.
   C. is equally good at absorbing heat from sunlight during the day and radiating away heat during the night.
   (D.) is not as good at absorbing heat from sunlight during the day, and not as good at radiating away heat during the night.
   E. is better at absorbing heat from sunlight during the day, but not as good at radiating away heat during the night.

10. As a high-altitude balloon sinks lower and lower into the atmosphere, which of its following properties is most likely to decrease?
    A. density
    B. pressure
    C. weight
    D. volume
    E. distance from the surface of the earth

There are two correct answers to this question. Either D or E is worth 2 points.

11. The Athletic Centre at U of T has an Olympic-sized swimming pool, which is 50 m long, and 4.2 m deep at the deep-end. At which of the following points in this swimming pool is the water pressure the greatest?
    A. At the jets, located about 1 m below the surface, where the water is moving into the pool.
    B. At the very bottom, near the drain.
    C. At the surface.
    D. At the centre of the pool, about 2.1 m below the surface.
    E. All points in the pool have approximately the same water pressure.

12. How many different elements are in a water molecule?
    A. 0
    B. 1
    C. 2
    D. 3
    E. 4

H and O