Name:
Student Number:

Physics 101 Summer Midterm

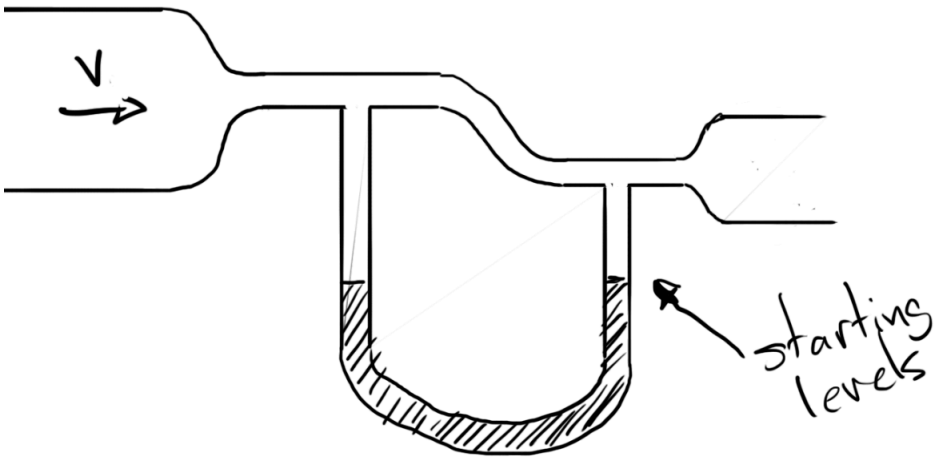
May 30th, 2016

Questions 1-9: Multiple Choice: 2 points each
Questions 10-13: Explain your work: 22 points total

Multiple choice answers:

#1	
#2	
#3	
#4	
#5	
#6	
#7	
#8	
#9	

Formula sheet at the back (you can remove it)

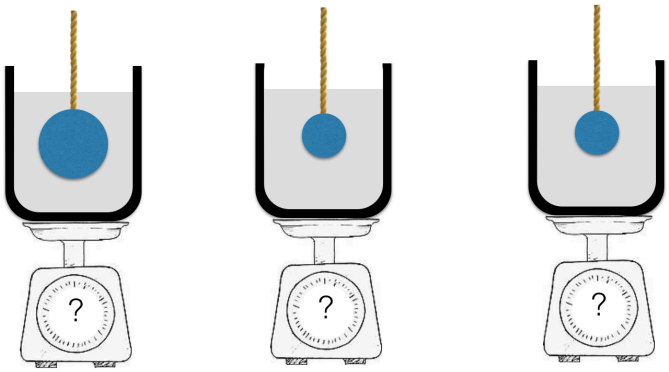


Question 1: James attempts to make a Venturi Meter and constructs the thing shown above. If fluid starts to flow, what will happen to the fluid levels in the U-tube?

A) The left will lower and the right will rise.
B) The right will lower and the left will rise.
C) The levels will stay the same.
D) There's not enough information to tell.

Question 2: Consider a mass hanging vertically from a spring and at equilibrium. If you pull it down by 2 cm and release it, it begins to oscillate at a frequency f. If you had pulled it down instead by 4 cm, what would its frequency of oscillation be?

A) f/4
B) f/2
C) f/√2
D) f
E) √2f
F) 2f
G) 4f



1. ball mass M radius 2R

2. ball mass M radius R

3. ball mass 2M radius R

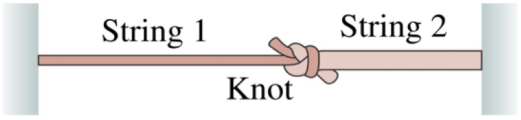
Question 3: The balls in the picture above are suspended from a rope in containers of water. Each container has the same level of water in it. Which is the correct ranking for weight each scale reads?

A) 1 = 2 = 3
B) 1 > 2 = 3
C) 2 = 3 > 1
D) 1 = 2 > 3
E) 3 > 1 = 2
F) 3 > 2 > 1

Question 4: A ball of mass M attached to a string swings back and forth with period T. If the mass is doubled, the period of the swing

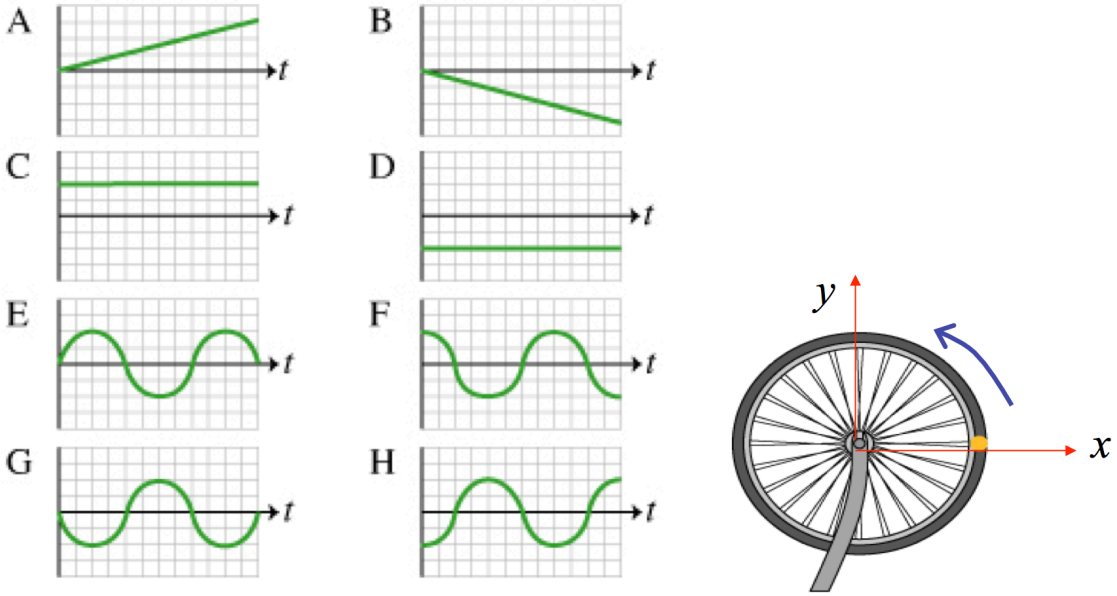
A) is quadrupled.
B) is doubled.
C) stays the same.
D) is halved.
E) is quartered.

Question 5: A sinusoidal wave travels from string 1 to string 2. Which of the following is true about the wave in each of the strings?



A) The wavelength is longer when the wave is in String 1
B) The wavelength is longer when the wave is in String 2
C) The wavelength is the same in both strings.
D) You don't have enough information to do this problem.

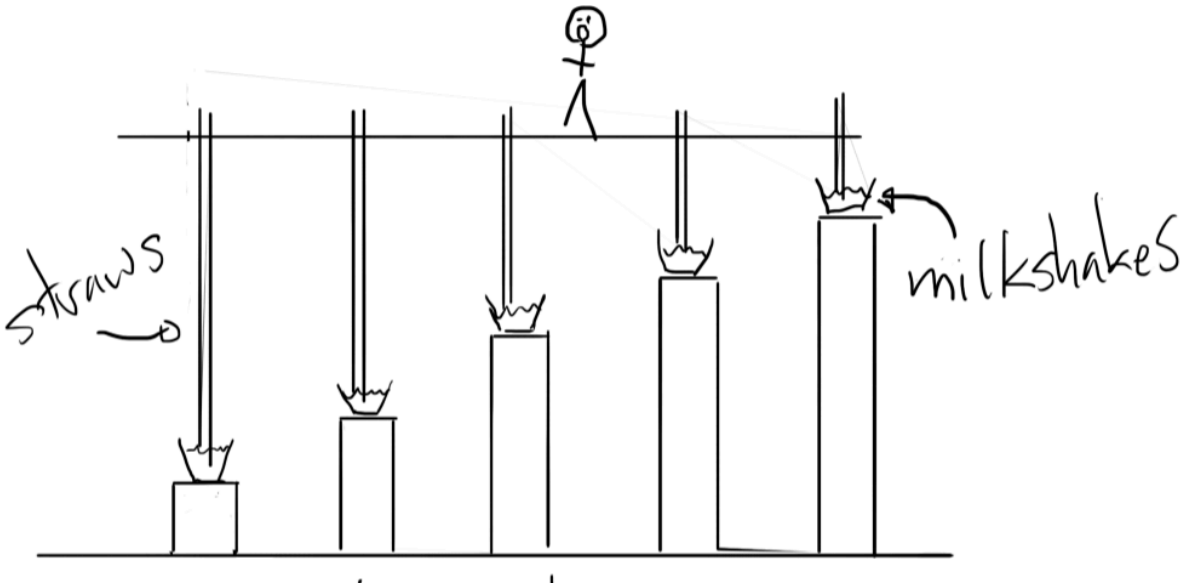
Question 6: Which graph describes the y-acceleration of the dot on the wheel? Assume the position shown is at $t = 0$.



Question 7: You give your sister a push on a swing. The chain of the swing is 3 meters long and you pull her back 2 meters. You want to calculate her speed maximum speed at the bottom of her swing. Which method should you use to give the most accurate answer?

A) Use simple harmonic motion.
B) Use conservation of energy.
C) It doesn't matter because they both give the same answer.
D) It can't be determined which method gives the more accurate answer.

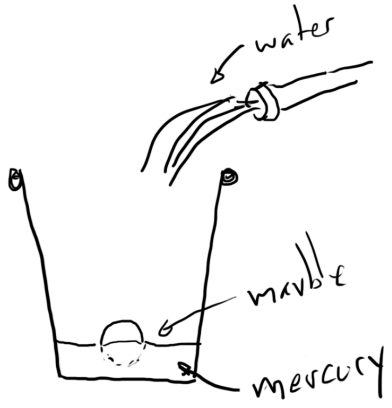
Question 8: You've entered a Milkshake drinking contest. The goal is to drink the milkshake from the longest straw possible. Ignoring an viscous properties of milkshakes, what is the longest straw of the ones shown that you could possibly drink the milkshake from?



A) 15m B) 12m C) 9m D) 6m E) 3m

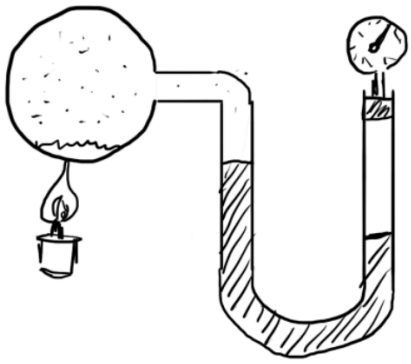
F) All straws are too long

Question 9: A marble sits half in and half out of mercury at the bottom of a cup. If you gently pour water into the cup as to not disturb anything, completely covering the marble, what can you say about the force the marble feels?



A) The marble gets pushed downward.
B) The marble gets pulled upward.
C) It feels the same force as before.
D) You can't tell.

Written Question 10 (4 points total)



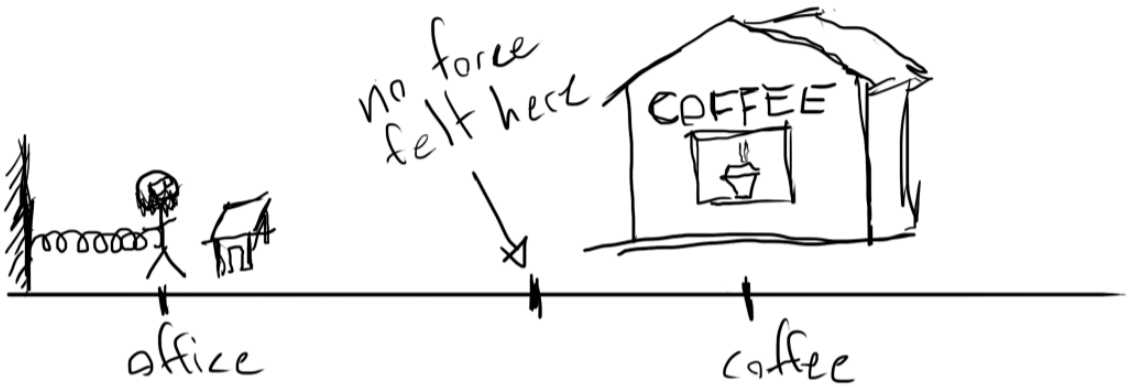
As part of your co-op work-term here at UBC you've designed a manometer pressure gauge to allow you to measure the pressure of a mystery gas inside a glass bulb created by boiling a fluid. After boiling the fluid in the bulb you find that the mercury in your manometer is 400 mm higher on one side than the other (as shown) and that the pressure on the gauge reads 4 atm.

What is the pressure of the mystery gas inside the bulb?

Written Question 11 (6 points total)

a) James's boat has sprung a leak in the bottom. The side of the boat is 0.75 m high and the water level outside of the boat is 0.1 m from the top of the boat. If the hole is 4.0 mm wide, at what rate does water flow into the boat (so James knows how fast he has to bail water out)? (4 points)

b) If James jumps out of the boat, what happens to the rate that water flows into the boat. Explain using words. (2 points)



Written Question 12 (6 points total)

James has designed a contraction to help him get coffee faster. Using a compressed spring, he can shoot himself from his desk to get coffee, and then come back. The spring he uses has k = 20 N/m and James has a mass of about 100 kg. James's office is 90 meters from the coffee shop in the Nest, and at a point 2/3rds of the way to the coffee shop, James experiences no force from the spring.

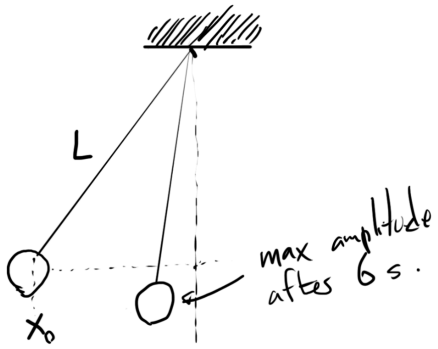
a) Write a function that describes James's motion assuming he starts at his office at t =0. (3 points)

b) What's James's maximum acceleration? Mark where is happens on the picture above. (2 points)

c) How long does it take James to get to his coffee? (1 point - this is very hard).

Written Question 13 (6 points total)

You're swinging a pendulum because you have to to pass physics 101. You pull the pendulum of mass m = 3 kg and length L = 1 m aside to a position x_0 = -8 cm as shown above (drawing not to scale). After 6 seconds you observe that the pendulum now only swings outward to a max of 2 cm from the middle.



a) Find the angular frequency, period, and damping constant of this pendulum. State your assumptions. (4 points)

b) In the space below, draw the function that describes the oscillation. Label important parts. (2 points)

Formula Sheet, Phys 101 (Revised Jan 31, 2015)

Fluids:

$$P = P_0 + \rho g h \qquad A_1 v_1 = A_2 v_2 \qquad P_{\text{gauge}} = P - P_0$$

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant} \qquad F_B = m_f g = \rho_f g V \qquad \rho = \frac{m}{V}$$

Harmonic Motion:

$$F = -kx \qquad PE = \frac{1}{2}kx^2 \qquad KE = \frac{1}{2}mv^2$$

$$x(t) = A\cos(\omega t + \phi_0) \qquad v(t) = -A\omega \sin(\omega t + \phi_0) \qquad a(t) = -A\omega^2 \cos(\omega t + \phi_0) = -\omega^2 x(t)$$

$$\omega = 2\pi f = \frac{2\pi}{T} \quad \left(f = \frac{1}{T}\right) \qquad \omega = \sqrt{\frac{k}{m}} \quad \text{(spring)} \qquad \omega = \sqrt{\frac{g}{L}} \quad \text{(simple pendulum)}$$

$$E = \frac{1}{2}kA^2 = \frac{1}{2}mv_{\max}^2 \qquad x_{\max}(t) = Ae^{-bt/2m} \qquad x(t) = Ae^{-bt/2m}\cos(\omega_D t + \phi)$$

$$E(t) = E_0 e^{-bt/m} \qquad \omega_D = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$

Travelling Waves:

$$k = \frac{2\pi}{\lambda} \qquad v = f\lambda = \frac{\omega}{k} \qquad v = \sqrt{\frac{T}{\mu}}$$

General equation for a travelling wave: $D(x,t) = D_M \sin(kx \mp \omega t + \phi_0)$

Sound:

$$I = \frac{P}{A} \qquad I = \frac{P}{4\pi r^2} \text{ (spherical wave)} \qquad \beta(\text{dB}) = 10\log_{10}\left(\frac{I}{I_0}\right)$$

$$f = f_0\left(\frac{1 \pm \frac{v_o}{v}}{1 \mp \frac{v_s}{v}}\right) = f_0\left(\frac{v \pm v_o}{v \mp v_s}\right) \qquad f_{beat} = |f_2 - f_1|$$

Interference & diffraction:

$$n = \frac{c}{v} \qquad \lambda_n = \frac{\lambda}{n}$$

Thin film interference: $\Delta\phi = 2\pi\frac{\Delta x}{\lambda} + \Delta\phi_0$

2-slit interference, with small angle approximation ($m = 0, \pm1, \pm2, \ldots$):

Bright fringes: $y_{\text{bright}} = m\frac{\lambda L}{d}$

Dark fringes: $y_{\text{dark}} = \left(m + \frac{1}{2}\right)\frac{\lambda L}{d}$

Single-slit diffraction minima with small angle approximation:

$$y_{\text{dark}} = p\frac{\lambda L}{a}, \text{ where } p = \pm1, \pm2, \ldots$$

Circular aperture: $\theta_{\min} = 1.22\frac{\lambda}{D}$

Areas & volumes:

$$A(\text{circle}) = \pi r^2 \qquad A(\text{sphere}) = 4\pi r^2 \qquad V(\text{sphere}) = \frac{4}{3}\pi r^3$$

$$V(\text{cylinder}) = \pi r^2 h$$

Constants:

$P_0 = P_{\text{atmosphere}} = 1.013\times10^5\,\text{Pa}$; $\rho_{\text{fresh water}} = 1.00\times10^3\,\text{kg/m}^3$;

$\rho_{\text{air}} = 1.29\,\text{kg/m}^3$; $\rho_{\text{mercury}} = 13.6\times10^3\,\text{kg/m}^3$; $g = 9.81\,\text{m/s}^2$

$I_0 = 10^{-12}\,\text{W/m}^2$; $v_{\text{sound}}(\text{in air}) = 343\ \text{m/s}$