PHYS 2211 Test 2
Fall 2014

Name(print)____ **Lab Section**__________________

Schatz(N), Bongiorno(M)					
Day	12-3pm	2-5pm	3-6pm	5-8pm	6-9pm
Monday		M01			
Tuesday	M03 N01		M06 N02		N03
Wednesday		M02 N07		M07	
Thursday	M04 N04		M05 N05		N06

Instructions

- Read all problems carefully before attempting to solve them.
- Your work must be legible, and the organization must be clear.
- You must show all work, including correct vector notation.
- **Correct answers without adequate explanation will be counted wrong.**
- Incorrect work or explanations mixed in with correct work will be counted wrong. Cross out anything you do not want us to grade
- Make explanations correct but brief. You do not need to write a lot of prose.
- Include diagrams!
- **Show what goes into a calculation, not just the final number, e.g.:** $\frac{a\cdot b}{c\cdot d} = \frac{(8\times10^{-3})(5\times10^{6})}{(2\times10^{-5})(4\times10^{4})} = 5\times10^{4}$
- Give standard SI units with your results.

Unless specifically asked to derive a result, you may start from the formulas given on the formula sheet, including equations corresponding to the fundamental concepts. If a formula you need is not given, you must derive it.

If you cannot do some portion of a problem, invent a symbol for the quantity you can not calculate (explain that you are doing this), and use it to do the rest of the problem.

Honor Pledge

"In accordance with the Georgia Tech Honor Code, I have neither given nor received unauthorized aid on this test."

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Sign your name on the line above

PHYS 2211

Do not write on this page!

Problem	Score	Grader
Problem 1 (25 pts)		
Problem 2 (25 pts)		
Problem 3 (25 pts)		
Problem 4 (25 pts)		

Problem 1 (25 Points) In an earlier lab you studied the motion of a fan cart, and you wrote a computer model (VPython script) to predict a fancart's motion. The script given below, which is nearly identical to your computer model from lab, is missing a few lines of code. In the space provided in the body of the script, add the statements necessary to complete the code.

```
#************BEGIN COMPUTER MODEL OF FANCART********************
from __future__ import division
from visual import *
cart = box(pos=vector(0.081,0,0), size=(.1,.04,.06), color=color.green)
mcart = .2395
vcart = vector(.375, 0, 0)
pcart = mcart*vcart
deltat = 0.01
t = 0
Fair = vector(-0.062, 0, 0)
while t < 5.01:
    rate(100)
```

(a 15pts) Add statements **here** to update the momentum and the position of the fancart.

```
    t = t + deltat

#************ END COMPUTER MODEL OF FANCART********************
```

This problem continues on the next page.

Refer to the code above to answer the following four questions:

(b 2pts) What is the initial position of the fancart?

(c 2pts) What is the initial momentum of the fancart?

(d 3pts) What is the net force on the fancart?

(d 4pts) If you were to run this code, would you observe the virtual fancart speeding up, slowing down or traveling at a constant velocity? Briefly state how you know this.

Problem 2 (25 Points)

In the following problems you will be asked to calculate the net gravitational force acting on the Moon. To do so, please use the following variables:

Mass	**Initial Position**
m_{sun} Mass of the Sun	$\vec{r}_{Sun} =< 0, 0, 0 >$ position of the Sun
m_{Earth} Mass of the Earth	$\vec{r}_{Earth} =< L, 0, 0 >$ position of the Earth
m_{Moon} Mass of the Moon	$\vec{r}_{Moon} =< L, h, 0 >$ position of the Moon

(a 10pts) Calculate the gravitational force on the Moon due to the Earth.

(b 10pts) Calculate the gravitational force on the Moon due to the Sun.

(c 5pts) Determine the net gravitational force on the Moon.

Problem 3 (25 Points)

A wire made of an unknown alloy hangs from a support in the ceiling. You measure the relaxed length of the wire to be 1.6 m long, and the radius of the wire to be 0.00035 m. When you hang a 5 kg mass from the wire, you measure that it stretches a distance of 4×10^{-3} m. The average bond length between atoms is 2.3×10^{-10} m for this alloy.

(a 5pts) If you treat the wire as a macroscopic spring, what is the overall spring stiffness of the wire? **Circle your answer below.**

A. 30.6 N/m
B. 11.7 N/m
C. 1.2×10^4 N/m
D. 5.1×10^{10} N/m
E. 2.1×10^{11} N/m

(b 5pts) What is the value of Young's modulus for this alloy? **Circle your answer below.**

A. 5.6×10^7 N/m^2
B. 11.7 N/m^2
C. 1.2×10^4 N/m^2
D. 5.1×10^{10} N/m^2
E. 2.0×10^{11} N/m^2

(c 5pts) What is the stiffness of a typical interatomic bond in the alloy?

A. 23.4 N/m
B. 11.7 N/m
C. 3.4 N/m
D. 5.9 N/m
E. 1.2×10^4 N/m

(d 5pts) You cut the wire into four pieces of equal length and hang a 5 kg mass from one of the wires. How much does this wire stretch? **Circle your answer below.**

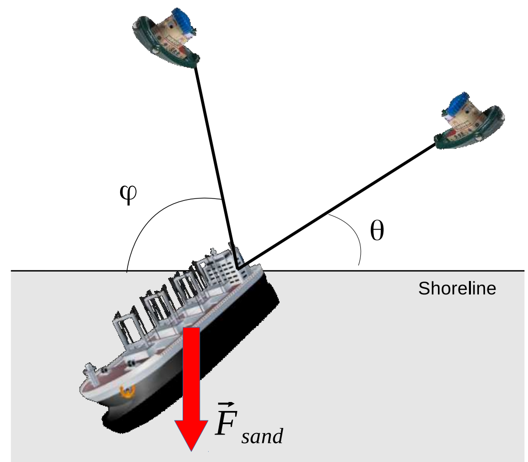
A. 4×10^{-3} m
B. 2×10^{-3} m
C. 1×10^{-3} m
D. 8×10^{-3} m
E. 1.6×10^{2} N/m

(e 5pts) You bundle (side by side) each of the four pieces of wire together and hang a 5 kg mass from the bundle. How much does this bundle of wires stretch? **Circle your answer below.**

A. 4×10^{-3} m
B. 2.5×10^{-4} m
C. 4×10^{-6} m
D. 2.5×10^{-5} m
E. 1.6×10^{-5} N/m

Problem 4 (25 Points)

Two tugboats are pulling a salvaged ship off the beach at high tide. The first tugboat pulls with a constant force of $\vec{F}_{tug}$ at an angle θ with the shoreline. The second tugboat pulls with an unknown constant force at an angle ϕ with the shoreline as indicated in the figure. Once both tugboats are pulling, the salvaged ship slowly slide off of the beach at a constant velocity. The beach sand, however, exerts a force on the salvaged ship as it is dragged off the beach. The magnitude of this force is unknown but by examining marks in the sand, you determine that the direction of this force is perpendicular to the shore line as seen in the figure. Determine the magnitude of $\vec{F}_{sand}$, the force of sand on the salvaged ship.



This page is for extra work, if needed.

Things you must have memorized

The Momentum Principle Definition of Momentum	The Energy Principle Definition of Velocity	The Angular Momentum Principle Definition of Angular Momentum
Definitions of angular velocity, particle energy, kinetic energy, and work		

Other potentially useful relationships and quantities

$$\gamma \equiv \frac{1}{\sqrt{1-\left(\frac{|\vec{v}|}{c}\right)^2}} \qquad E^2-(pc)^2=\left(mc^2\right)^2$$

$$\frac{d\vec{p}}{dt}=\frac{d|\vec{p}|}{dt}\hat{p}+|\vec{p}|\frac{d\hat{p}}{dt} \qquad \vec{F}_{\parallel}=\frac{d|\vec{p}|}{dt}\hat{p} \text{ and } \vec{F}_{\perp}=|\vec{p}|\frac{d\hat{p}}{dt}=|\vec{p}|\frac{|\vec{v}|}{R}\hat{n}$$

$$\vec{F}_{grav}=-G\frac{m_1m_2}{|\vec{r}|^2}\hat{r} \qquad U_{grav}=-G\frac{m_1m_2}{|\vec{r}|}$$

$$\left|\vec{F}_{grav}\right|\approx mg \text{ near Earth's surface} \qquad \Delta U_{grav}\approx mg\Delta y \text{ near Earth's surface}$$

$$\vec{F}_{elec}=\frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{|\vec{r}|^2}\hat{r} \qquad U_{elec}=\frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{|\vec{r}|}$$

$$\left|\vec{F}_{spring}\right|=k_s s \qquad U_{spring}=\frac{1}{2}k_s s^2$$

$$U_i\approx\frac{1}{2}k_{si}s^2-E_M \qquad \Delta E_{thermal}=mC\Delta T$$

$$\vec{r}_{cm}=\frac{m_1\vec{r}_1+m_2\vec{r}_2+\dots}{m_1+m_2+\dots} \qquad I=m_1r_{1\perp}^2+m_2r_{2\perp}^2+\dots$$

$$K_{tot}=K_{trans}+K_{rel} \qquad K_{rel}=K_{rot}+K_{vib}$$

$$K_{rot}=\frac{L_{rot}^2}{2I} \qquad K_{rot}==\frac{1}{2}I\omega^2$$

$$\vec{L}_A=\vec{L}_{trans,A}+\vec{L}_{rot} \qquad \vec{L}_{rot}=I\vec{\omega}$$

$$\omega=\sqrt{\frac{k_s}{m}} \qquad v=d\sqrt{\frac{k_{si}}{m_a}}$$

$$Y=\frac{F/A}{\Delta L/L}\text{ (macro)} \qquad Y=\frac{k_{si}}{d}\text{ (micro)}$$

$$\Omega=\frac{(q+N-1)!}{q!\,(N-1)!} \qquad S\equiv k\ln\Omega$$

$$\frac{1}{T}\equiv\frac{\partial S}{\partial E} \qquad \Delta S=\frac{Q}{T}\text{ (small }Q\text{)}$$

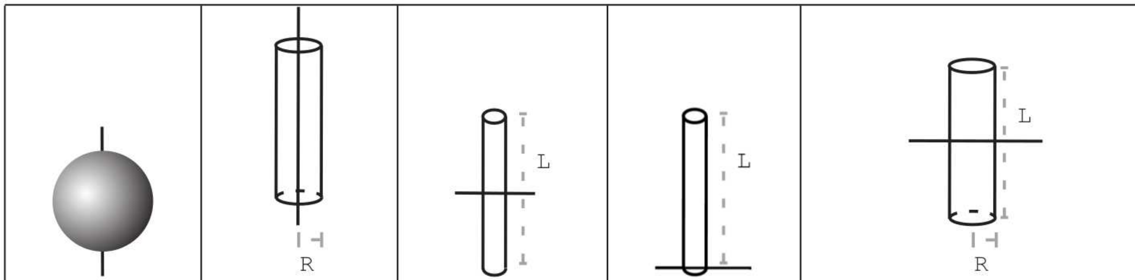
$$\text{prob}(E)\propto\Omega\,(E)\,e^{-\frac{E}{kT}} \qquad E_N=-\frac{13.6\text{eV}}{N^2}\text{ where }N=1,2,3\dots$$

$$E_N=N\hbar\omega_0+E_0 \text{ where } N=0,1,2\dots \text{ and } \omega_0=\sqrt{\frac{k_{si}}{m_a}} \text{ (Quantized oscillator energy levels)}$$

Moment of intertia for rotation about indicated axis

The cross product

$$\vec{A} \times \vec{B} = \langle A_y B_z - A_z B_y, A_z B_x - A_x B_z, A_x B_y - A_y B_x \rangle$$



$I = \frac{2}{5}MR^2$	$I = \frac{1}{2}MR^2$	$I = \frac{1}{12}ML^2$	$I = \frac{1}{3}ML^2$	$I = \frac{1}{12}ML^2 + \frac{1}{4}MR^2$

Constant	Symbol	Approximate Value
Speed of light	c	3×10^8 m/s
Gravitational constant	G	6.7×10^{-11} N $\cdot$ m^2/kg^2
Approx. grav field near Earth's surface	g	9.8 N/kg
Electron mass	m_e	9×10^{-31} kg
Proton mass	m_p	1.7×10^{-27} kg
Neutron mass	m_n	1.7×10^{-27} kg
Electric constant	$\frac{1}{4\pi\epsilon_0}$	9×10^9 N $\cdot$ m^2/C^2
Proton charge	e	1.6×10^{-19} C
Electron volt	1 eV	1.6×10^{-19} J
Avogadro's number	N_A	6.02×10^{23} atoms/mol
Plank's constant	h	6.6×10^{-34} joule $\cdot$ second
hbar $= \frac{h}{2\pi}$	$\hbar$	1.05×10^{-34} joule $\cdot$ second
specific heat capacity of water	C	4.2 J/g/K
Boltzmann constant	k	1.38×10^{-23} J/K

milli	m	1×10^{-3}	kilo	K	1×10^3
micro	μ	1×10^{-6}	mega	M	1×10^6
nano	n	1×10^{-9}	giga	G	1×10^9
pico	p	1×10^{-12}	tera	T	1×10^{12}