INSTRUCTIONS DO Problems 1,2 and 3, then any 5 of the remaining 9 problems. Clearly indicate those problems that you want graded by crossing out any work that you don't want graded . Otherwise I grade the first five (5) that have any work.

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NAME ____

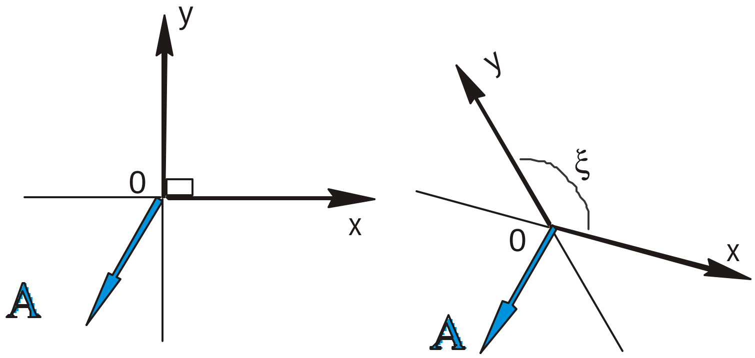
Borough of Manhattan Community College — Course ***Physics 215***

Instructor: ***Dr. Hulan E. Jack Jr.*** — Date **December 19 , 2002**

Final Exam

1. [12 pts Total]

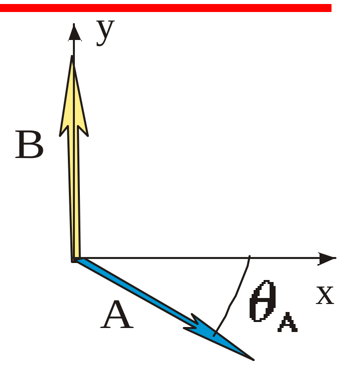
a. What is a vector? Describe its defining features. **[4 pts]**



b. The vector A is shown in two coordinates systems. On each coordinate system sketch the x and y components of A for that system. **Briefly** explain the reason for your solutions. **[8 pts]** (4 pts each)

2. [16 pts Total] The figure shows two vectors **A** and **B** .

A = 15 units, **B**=10 units and $\theta_A = 30^o$.



a. Sketch the vector **D** = **A -B** *directly on the figure*. **[3 pts]**

b. Write the components of the two vectors **[4 pts]**

Symbols	**Values**	**Symbols**	**Values**
A_x =		B_x =	
A_y =		B_y =	

c. Write the expressions for the components, magnitude and direction of the vector **D** = **A - B** in terms of A_x, A_y, B_x , and B_y.

[9 pts total] **SYMBOLS ONLY**

3. **[12 pts Total]** Using the information 1 Cal = 1kcal = 1000cal , 1 cal = 4.18J, 1 watt = 1J/s, 1 day = 24 hr, 1 hr = 60 min, 1 min = 60 s.

a. Set up the program to go from 1000 Cal/day to watt (1000 Cal/day = (?) watts) using **all** of the above information (**no numbers yet - just units**) [**4 pts**]

b. Explain by illustrating how to check the correctness of the setup program. [**2pts]**

c. Fill in the numbers **in the above setup program**. [**2 pts]**
(OK, now numbers)

d. Explain by illustrating how to check the numbers for correct positions. **[4 pts]**

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4. **[12 pts Total]**

A body initially rotating at a constant angular velocity ω_0 = 40 rad/s comes to rest (ω=0) in time t_s after rotating 80 rad (radians). Assuming constant angular acceleration α, find t_s and α.

Sketch the angular velocity vs time, ω vs t, curve [4pts]	**State The Principle(s) [4pts] with equations**	**Solve for t_s and α [2pts each] symbols then numbers**

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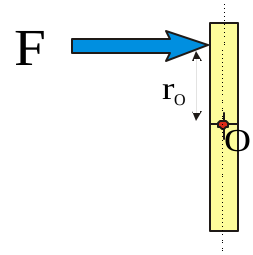
5. **[12 pts Total]** The rod with mass m = 2.0 kg, length L = 1 m, and Moment of Inertia about O $I_O = 0.167\ kg\ m^2$, is held in vertical position as shown. It is released and hit with a swift horizontal force **F =** 5N, as shown in the picture. Imagine that it is space so there is no gravity acting.

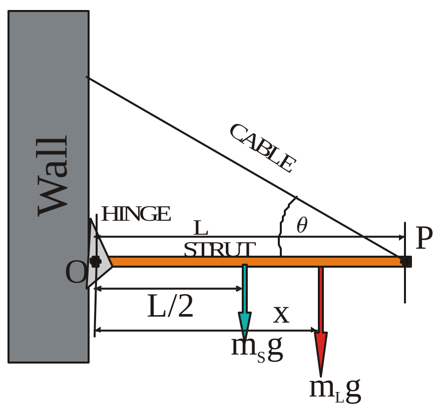


a. Describe the motion of the stick when the force hits on the center of mass O;

b. when it hits a distance r_O = 0.50 m from O.

State the Physical Principle (s) [2pts each]	**Fill in the Details [2 pts each]**	**Describe the motion.[2pts each]**
a.		
b.		

6. **[12 pts Total]** A horizontal uniform strut of mass m_S and length L is supported by a hinge at O and a cable at P. The cable makes an angle θ with the horizontal, A load of mass m_L is a distance x from O. Find the tension T in the cable in terms of m_S , m_L , L, x and θ.



Sketch FBD of the strut. 3 pts

State Physical Principle (s) 4 pts

Fill in the details and solve.
5 pts

7. **[12 pts Total]** The absolute potential energy due to gravity of a small body of mass m a distance R from the center of a another large body of mass M, like a planet, is E_P = - GMm/R, where G is the Universal Gravitational Constant, G = 6.67 x 10^{-11} Nm^2/kg^2. Show that the escape velocity, v_e , of m from M is v_e = sqrt(2GM/R).

Write the total energy of m if it is moving with velocity v. 4 pts

What is meant by escape velocity v_e? How is it defined. 4 pts

Solve for the escape velocity v_e. 4 pts

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8. **[12 pts Total]** A simple pendulum consists of a mass m = 1 kg of very very small radius hanging at the end of a metal wire of length of L_0 = 1 m at T = 30° C. The temperature is raised to 100° C. The wire material has a coefficient of linear expansion α = 2.0 x 10^{-5} /°C.

a. Show that the **period , P**, of the pendulum at T= 30 °C is P = 2πsqrt(L_0/g).

Sketch a picture of the pendulum to get P. 2 pts.

State Physical Princple(s) 2 pts

Do it. 2pts

b. Find the expression for the **period P** in terms of L_0 , α and ΔT, that is P(L_0, α, ΔT).

State Physical Principle(s) 3 pts.

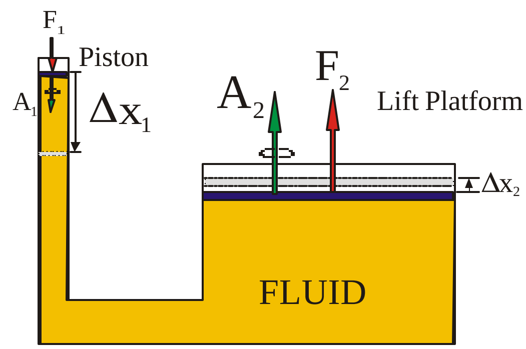
Get P(L_0, α, ΔT). 3 pts

Final Exam

9. **[12 pts Total]** A hydraulic lift is schematically shown in the picture. The piston has area $A_1 = 0.01 m^2$ and the Lift platform area $A_2 = 4\ m^2$. A force $F_1 = 100$ N pushes the piston down by a displacement $\Delta x_1 = 10$ m.

SYMBOLS ONLY! NO NUMBERS!

a. Find the relationship between F_1, F_2, A_1 and A_2 .



State Physical Principle (s) 2 pts	**Details and Results** 4 pts

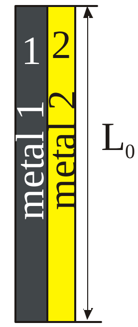
b. Find relationship between F_1, F_2, Δx_1 and Δx_2 .

State Physical Principle (s) 2 pts	**Details and Results** 4 pts

10. **[12 pts Total]]** On initially a windless day a leaf rests on the ground. Then a gentle breeze of air starts moving across the leaf with velocity v = 5 m/s. What happens to the leaf . Explain.

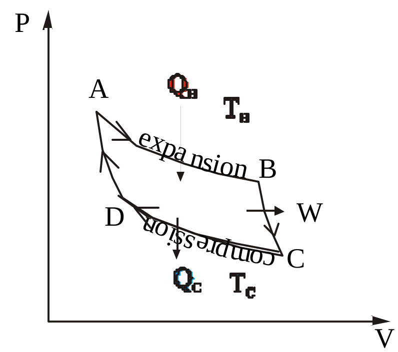
Add whatever is needed to explain what happens when the breeze starts to blow. 3 pts.	**State Physical Princple(s)** 3 pts	**Expalin what happens and why**. 6 pts

11. **[12 pts total]** Total] A bimetallic strip consists of two pieces of metal of different coefficients of linear thermal expansion have been welded together. The coefficients of linear thermal expansion of the metals are α_1 and α_2 , where $\alpha_1 > \alpha_2$. At some initial temperature, T_0, the two strips have the same length, L_0 , as shown in the picture. What happens when the temperature of the strip increases by ΔT .



Sketch the strip after its temperature rises. 3 pts	**State Physical Principle (s)** 4 pts	**Explanation** 5 pts

12. **[12 pts total]** Shown is the cycle of an ideal gas engine. As it expands from A to B, it absorbs heat Q_H from the hot environment which is at absolute temperature T_H . As it compresses from C to D it dumps heat Q_C into the cold environment which is at absolute temperature T_C. It does work on some external system.



How much work does it do? What Law applies? Briefly explain. [4 pts]

How can you change this so that it operate as a refrigerator?
What does a refrigerator do. [2 pts]

On the diagram, sketch and label the changes in the cycle. Briefly explain what is happening [6 pts]