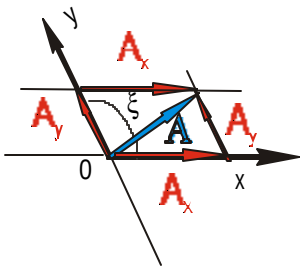
NAME(print)__Me____My Solutions____Hulan E. Jack Jr._____Mar. 20, 2003
Borough of Manhattan Community College Course ***Physics 215***
Instructor: ***Dr. Hulan E. Jack Jr.*** Date ***March 20, 2003***

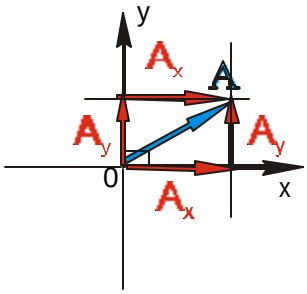
Boot Camp Final - My Solutions Preliminary

1. [20 pts Total]

a. What is a vector? Answer by describing its defining features. **[6 pts]**

A vector is a quantity that has both magnitude (size) and direction. These two, magnitude and direction are the vectors defining features.





b. The vector A is shown in two coordinates systems. On each coordinate system sketch the x and y components of A in each system. **Briefly** explain the reason for your solutions. **[14 pts]** (7 pts each)

The components of a vector are a set of vectors, one vector parallel to each coordinate axis, such that the vector sum of the components equals the original vector. Both of the examples shown satisfy these conditions. In each case, A_x and A_y are parallel to the x and y axes, respectively. And their vector sums equal the original vector A.

FS00

2. [10 pts Total]

In each of the following, use Dimensional Analysis to determine whether the formula can be correct. If it cannot be correct, then make whatever changes or additions needed to make it possibly correct. **Put additions in a different color**.

$F = L\sin\theta$? Where F =force ($N = ML/T^2$) and L = length.

F has dimensions $F = [N] = [ML/T^2]$. L has dimensions [L]. So the equation can never be true! The right side of the equations must be multiplied by entities with total dimensions of $[M/T^2]$.

$T = 2\pi\ (g/L)^{1/2}$? Where T=period (sec), g = acceleration = $9.8 m's^2$ and L = length.

T has dimensions [T]. g has dimensions $[L/T^2]$. L has dimensions [L].
So, $(g/L)^{1/2}$ has dimensions $[(\cancel{L}/T^2)/\cancel{L}]^{1/2}$. The L's cancel, leaving $[1/T^2]^{1/2} = 1/T$.
But, it must be T. So, it must be **$T = 2p\ (L/gL)^{1/2}$** .

$Fv = mv^2$? Where F =force ($N = ML/T^2$) , v = velocity and m = mass .

Fv has dimensions $[N][L/T] = [ML/T^2][L/T] = [ML^2/T^3]$. mv^2 has dimensions $[ML^2/T^2]$.
CONTINUE LATER - out of time right now . Fri Mar 21, 2003 8:15 AM

In trying to understand, I push myself to the limits of frustration.
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3. **[20 pts Total]** Using the information m = 39.37 in, 1 f (foot) = 12 in, 1mi (mile) = 5,280 f (feet) 1 hr = 3600 sec.

a. Set up the program to go from m/sec to mi/hr using **ONLY** of the above data. (1 m/sec = (?) mi/hr) (**no numbers yet - just units**) [5 pts]] m -> in -> f -> mi / sec ->hr

a. and **c.** combined

$$\frac{m}{sec} = \frac{m(39.37)\frac{in}{m}(\frac{1}{12})\frac{f}{in}(\frac{1}{5280})\frac{mi}{f}}{sec(\frac{1}{3600})\frac{hr}{sec}}$$

NOT REQUIRED

=100*3600*39.37/(12*5280)=2.237mi/hr

b. Explain by illustrating how to check the correctness of the setup program. [5pts]

The units must be in a above/below , numerator/denominator, sequence such that all cancel leaving only the desired final unit. For example, in the m ->in conversion , m cancels m.

c. Fill in the numbers **in the above setup program**. [5 pts]

(OK, now numbers)

d. Explain by illustrating how to check the numbers for correct positions. **[5 pts]**

Starting with the m->cm step on the left, make the substitution shown in **red** , m -> m = 39.37in. If it cancels, as it does on the left hand example, you are OK. If it does not cancel, as on the right hand example, correct it by turning the number upside down, (1/39.37) -> (39.37) .

$$m(39.37)\frac{in}{m} \qquad m(39.37)\frac{in}{[m = 39.37in]} \qquad m(\frac{1}{39.37})\frac{in}{m} \qquad m(\frac{1}{39.37})\frac{in}{[m = 39.37in]}$$

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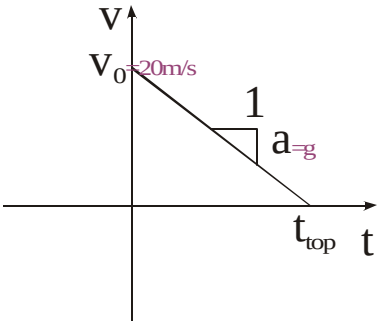
4. **[20 pts Total]** A body is thrown upward with an initial velocity v_0 = 20 m/s. How high, y_{max} , is it when it reaches the top and how long, t_{top} ,does it take? **[Hints**: 1.At top v=0. 2. a = g = 9.8m/s^2 down.**]**

FF99

Sketch the velocity vs time curve [8]



State The Principle(s) [6]

Δy = area under v vs t curve = y_{max}

a = slope of v vs t curve. = $\Delta v/\Delta t = (v_{top} - v_0)/t_{top}$

Solve for t_{top} and y_{max} in terms of v_0 and a = g.[6]

y_{max} = area of triangle = ½ v_0 t_{top} (1)

$a = g = (0 - v_0) / t_{top}$

SOME MATH

So, $\mathbf{t_{top} = - v_0 / g}$ (2)

Combinng with (1) gives

$\mathbf{y_{max}} = ½ v_0 t_{top} = ½ v_0(- v_0 /g)$

$= \mathbf{- ½ v_0^2 / g}$ (3)

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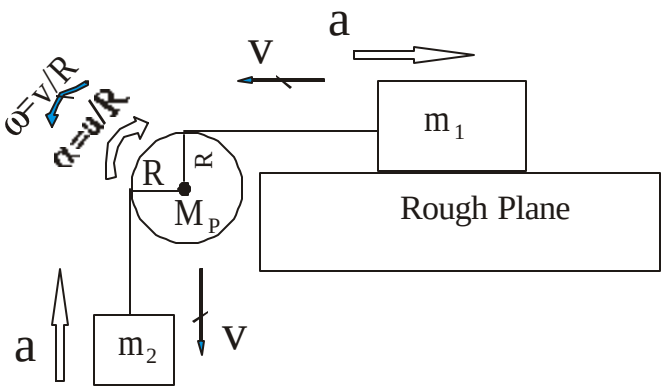
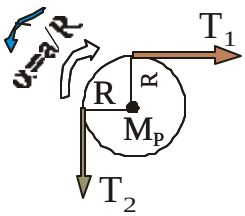
5. **[30 pts Total]**

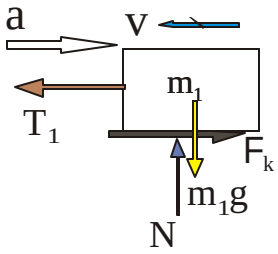
A block of mass m_1 = ? kg slides, as shown, on a rough horizontal plane that has a coefficient of kinetic friction μ_k =? . It is connected to a mass m_2 = 10 kg by a massless inextensible cord by way of a pulley of radius R=0.1m, mass M_P = 2 kg and $I_O = 0.3\ M_P$ kg m^2 . The cord turns the pulley without slipping. The pulley has frictionless bearings. First find the acceleration **a**. Then find the relation between m_1 , m_2 and μ_k so that the acceleration is in the direction shown.

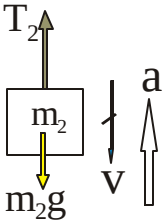


NOTE: ONLY THE SETUP IS ASKED FOR!!!!

Complete the Free Body Diagram of each body below. [14]







State Physical Principles [10]

Fill in the Details [6]

m_1: $\text{up}+\Sigma F_v = 0$; $N - m_1 g = 0$ (1)

$\rightarrow+\Sigma F_h = m_1 a$; $F_k - T_1 = m_1 a$ (2)

Pulley: $\text{cw}\ \Sigma\tau_O = I_O\alpha$; $RT_1 - RT_2 = I_O\alpha$ (3)

m_2: $\text{up}+\ \Sigma F_v = m_2 a$; $T_2 = m_2 a$. (4)

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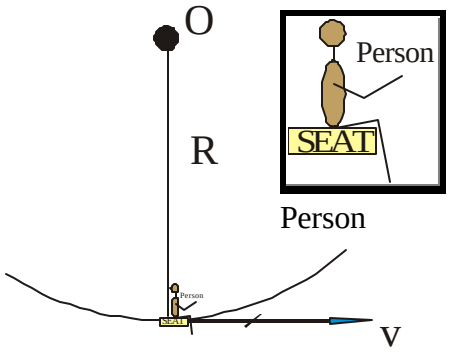
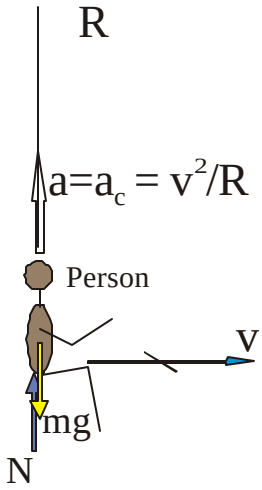
6. [20 pts Total]

An airplane in the bottom of a dive, momentarily traveling in a vertical circle of radius R = 5000 m, with a tangential velocity **v**, as shown. A person of mass m sits in a seat in the airplane. Find the velocity at which the normal force, N, of the seat pushing up on the person will be n times the persons weight, that is N = nW = nmg . The insert shows a blown up picture of the person in their seat. Towards this do the following.



Complete the Free body Diagram of the person [5]



State the Physical Principle(s) [5]

Fill in the Details [5]

up+ $F_v = ma$;

$a = a_c = v^2/R$; $N - mg = m\,v^2/R$ (1)

Solve for **v** in terms of terms of n g and R [5] .

THIS IS ALL MATH

Eq.(1) gives

$N = mg + mv^2/R$

$= mg(1+v^2/(gR))$ after factoring out mg

We want v for N = nmg, so

$N = nmg = mg(1+v^2/(gR))$,

cancel mg yields

$n = 1 = v^2/(gR)$.

Isolating v^2 gives

$v^2 = (n-1)gR$

So,

$v = \text{sqrt}((n-1)gR)$.

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