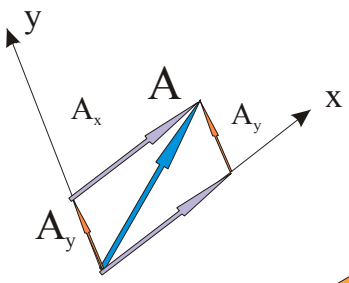
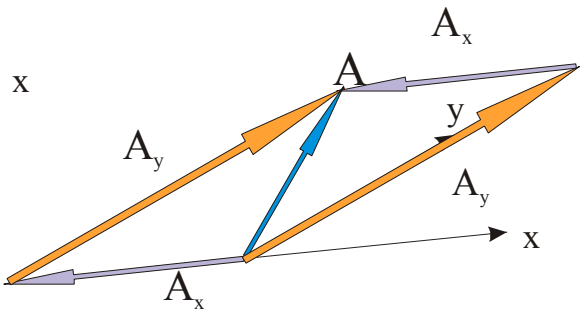
NAME(print)_ Me __ Hulan E. Jack Jr. _____My Solutions_____
Borough of Manhattan Community College Course ***Physics 215***
Instructor: ***Dr. Hulan E. Jack Jr.*** Date ***April 4, 2002***

Boot Camp Final

1. Sketch the A_x and A_y components in each picture. Do it on the pictures.

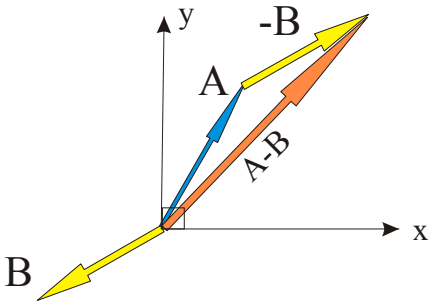


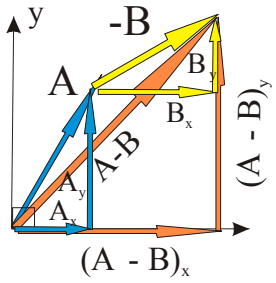


NOT ASKED FOR FOR THE EXAM

For components,
A_x is || to x axis,
A_y is || to y axis,
and
$A = A_x + A_y$.

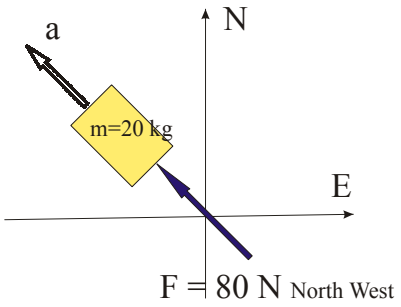
2. Sketch the vector A- B, 3 points
then the components A_x , A_y , $(-B)_x$, $(-B)_y$, $(A-B)_x$, $(A-B)_y$. 2 points each set
You can do them on the picture.





The two are done separately for clarity.

3. A net force F = 80 N North West acts on a body of mass m = 20 kg .
What is the body's acceleration, a ? Include units. 5 points
Sketch a picture of the situation. 5 points



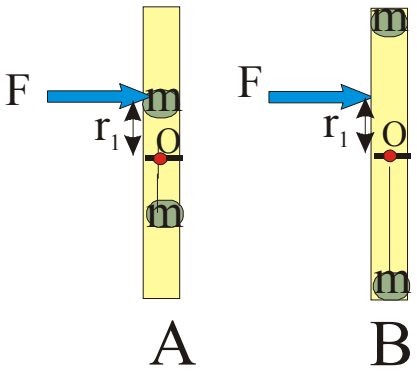
F = ma.

So, a = F/m

a = 80 N North West /20 kg = 4 m/s^2 North West.

The acceleration is in the same direction as the force.

4. You have a massless stick and two blobs both having a mass m. The center of stick is marked by the line with the dot. Two placements of the blobs are shown in the figures A and B. The blobs are the same distance from the center. In each, a force F is applied at a distance r_1 from the center of the stick.
Briefly describe what happens in each situation . 3 points



Answer below.

Definition 2 points	**Details for this situation** 3 points
torque $\tau_O = rXF = rF_\perp$	$\tau_O = r_1F$
Moment of Inertia $I_O = \Sigma m_i r_{iO}^2$	$I_O = mr_1^2 + mr_1^2 = 2mr_1^2$.

In each situation the stick accelerates both linearly and rotationally. By Newton's 2nd Law of linear motion , F=ma, the linear acceleration will be the same in both situations.

Relation between them. 2 points

But rotation is different. Newton's 2nd Law for rotation is $\Sigma\tau_O = I_O\alpha$, where α is the angular acceleration. As r_1 gets larger, I_O increases (by square) the angular acceleration decreases.

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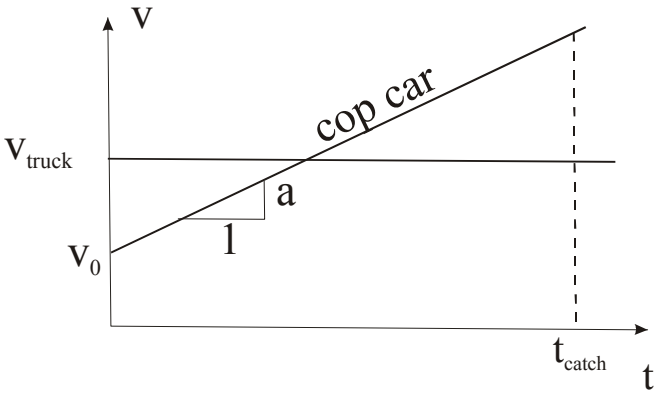
5. A cop car is traveling along at a velocity $v_0 = 20$ m/s when a truck passes it traveling a velocity $v_{truck} = 40$ m/s. The car immediately accelerates at the rate $a = 3m/s^2$. At time t_{catch} the cop car catches up with the speeding truck. This is shown on the v vs t curve. At t_{catch} what must be true ? How would you use it to find the value of t_{catch} ? Explain.



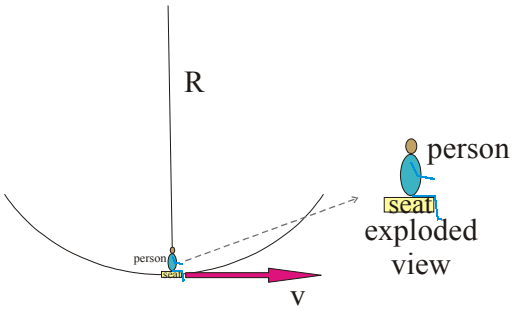
At catchup the two vehicles have traveled the same displacement. Hence the area under their v vs t curves are the same. The areas depend on t_{catch} . Some algebra gives t_{catch} .

NOT REQUIRED FOR THE EXAM

$x_{truck} = x_{car}$
$v_{truck}\, t_{catch} = v_0 t_{catch} + \frac{1}{2} a\, t_{catch}^2$

This yields $t_{catch} = 2\,(v_{truck} - v_0)/a$

6. A person of mass m = 80 kg. sits in the seat of an airplane. The airplane is momentarily at the bottom of a dive traveling a vertical circle of radius R = 2000 m. Its velocity v = 200 m/s. Sketch the Free Body Diagram of the person (use the figure), state principles and fill in the details.



FBD of person		State Principles	Fill in the Details
$a_c = v^2/R$	4pts	3pts	3 pts
W=mg, N(Normal), v, seat		$+\uparrow \Sigma F = ma$ $a = a_c = v^2/R$	$N - mg = mv^2/R$

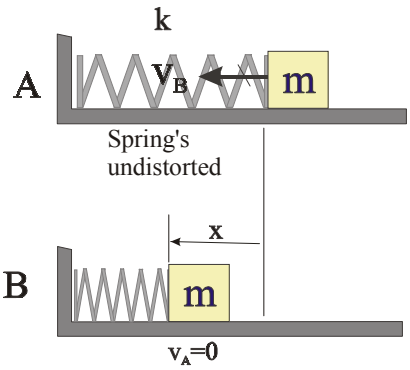
Note: Always put forces where they actually act. The Normal, N, acts on the bottom of the person by the seat pushing them up, NOT ON THE TOP AS IF THEY ARE HANGING!

Analysis (Not required for exam)

The Normal, N, is force that the seat pushes up on the person. It is the "effective" of the person.

$N = mg + mv^2/R = mg(1+v^2/(gR))$ factoring out mg
$= W(1+v^2/(gR))$ Since W =mg

7. A block of mass m = 10 kg travels along a horizontal rough plane which causes a kinetic friction force $\mathcal{F}$ on the block. The block has a velocity v_0 = 20m/s when it makes contact with a free spring of stiffness k = 10000N/m. The block comes to rest after compressing the spring by x = 0.1 m. Find the value of the friction force $\mathcal{F}$.



Principles

Conservation of Energy

$PE_A + KE_A = PE_B + KE_B + Work_{Other}$

Details (Symbols Only)

DETAILS

$$\underset{\text{Spring undeformed}}{0} + \tfrac{1}{2} m v_0^2 = \underset{\text{Spring compressed}}{\tfrac{1}{2} k x^2} + \underset{\text{stopped}}{0} + \mathcal{F} x$$

NOT REQUIRED FOR THE EXAM

After some algebra

$$\mathcal{F} = \tfrac{1}{2} (m v_0^2 - k x^2) / x$$

8. Derive that for a distance R from the center of a massive body of mass M that the gravitational intensity $g = GM/R^2$. R is $R_{Surface}$, or larger; $R > R_{Surface}$.

Newton's law of Gravitation is $F_G = - GMm/R^2$

Weight, W, is the force due to gravity.

So, $W = F_G = GmM/R^2$ when $R > R_S$, where R_S is the radius of the massive body.

Newton's 2nd Law of Motion (linear) is F=ma. For weight acting acceleration is due to the acceleration due to gravity. Hence a = g.

Combining these yields $W = mg = GmM/R^2$. Cancelling m gives $g = GM/R_2$ for $R > R_S$.

Boot Camp Final

9. The equation of motion of a physical system is found to be

$$(I_0 + ML^2)\,\alpha = -\,MgL\theta \quad .$$

It is released from rest at an angle θ_0 .

A. What is the frequency of this motion. Explain, show your arguments.
6 points

Simple Harmonic Motion is characterized by acceleration = $-(2\pi f)^2$ displacement, giving
$f = (1/2\pi)$ sqrt(acceleration/displacement).
Here the acceleration is the angular acceleration α and the displacement , the angular displacement θ. Hence ,
$f = (1/2\pi)\ MgL/(I_0 + ML^2)$

B. In terms of θ_0, I_0 , L and M , write the equation describing motion of this system. Explain.

4 points

Simple Harmonic Motion is described by the equation Displacement = Amplitude $\sin(2\pi t)$.

Here the displacement is the angular displacement θ, the amplitude θ_0. So,

$$\theta = \theta_0 \sin(\ MgL/(I_0 + ML^2)\ t)$$

10. What is stress? Give its definition. 3points

By definition, Stress σ = Force/ Area = F/A

What is the response to stress? Give its name and definition. 3 points

The response to stress is strain, ε, defined as $\varepsilon = \Delta L / L_0$

How are they related? 1 point

The two are related by the elastic modulus, M, of the materials by

$$\sigma = M\,\varepsilon$$

Name the three types of stress. 3 points
the three types of stress are axial, shear, and pressure.