Notre Dame University. Department of Mechanical Engineering
Test #1-MEN101 (Dynamics) *1hr20 minutes*
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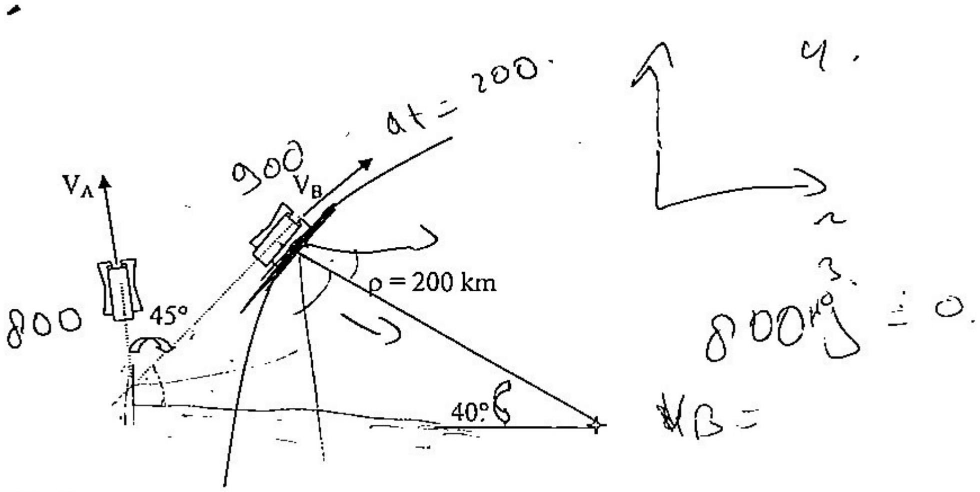
Problem#1(25pt)

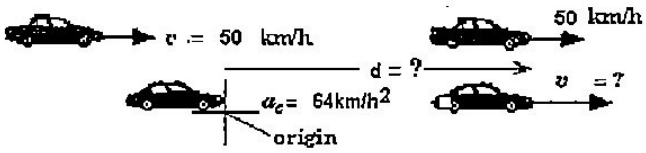
Two planes are flying at a speed V_A = 800km/h and V_B = 900km/h as shown in the figure below. A has a constant speed and B is accelerating at 200 km/h^2.
Find the magnitude and direction of $V_{B/A}$ and $a_{B/A}$? (show direction on figure).



Problem#2(25pt)

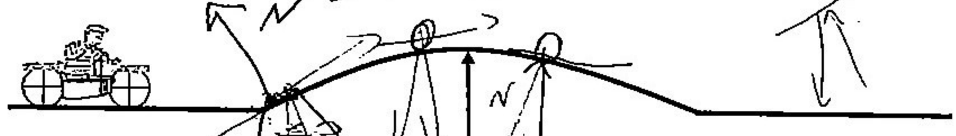
A car is moving at a constant speed of 50km/h passes you. At the moment it passed, you started accelerating uniformly at a rate of 64km/h^2 to follow him.

a) How long will it take you to overtake the passing car?
b) How long will you travel before you overtake the passing car?
c) How fast will you be moving when you overtake the passing car?



Problem#3(25pt)

A cyclist encounter a bump caused by the intersecting road as shown below. Neglect size of bicycle and rider. Find the maximum constant speed he can travel without leaving the surface of the road. The rider and the bicycle have a total weight of 280 lb.



Problem#4(25pt)

A 100 kg rock is dropped from 10,000 km above the surface of the Earth directly above the equator. The Earth's equatorial radius is 6378 km and its mass is 5.974×10^{24} kg. Neglect air resistance.

-What is the initial acceleration in term of G of the rock when it is dropped ?

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Zouk Mosbeh - Lebanon

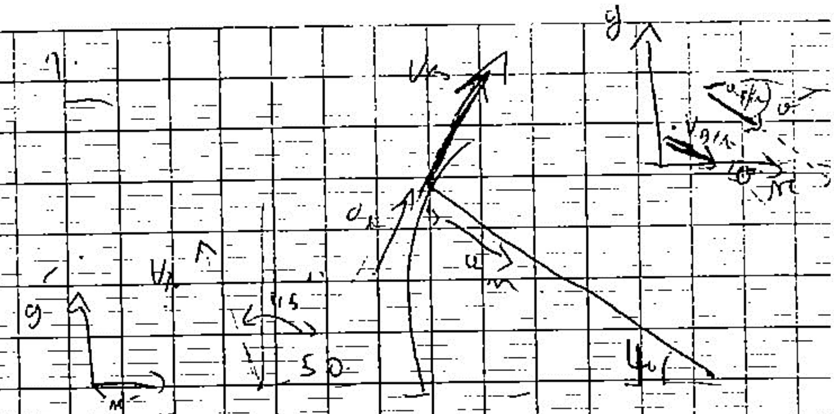
Grade: 98

TEST 1

Course No: MEN 101 Section: B Date:

(24)

Problem 1



$\vec{V}_A = 900 \cos 50\, \vec{i} + 900 \sin 50\, \vec{j}$

$\vec{V}_B = -800 \cos 85\, \vec{i} + 800 \sin 85\, \vec{j}$

$\vec{V}_{B/A} = \vec{V}_B - \vec{V}_A = (900 \cos 50 + 800 \cos 85)\, \vec{i} + (900 \sin 50 - 800 \sin 85)\, \vec{j}$ OK

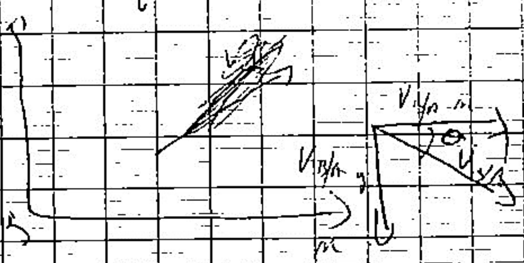
$= 648.23\, \vec{i} - 101.52\, \vec{j}$

$|V_{B/A}| = 657.08$ Km/h

magnitude of $V_{B/A} = 657.08$ km

direction

be clearer, show consistency (-1)



$\tan\theta = \frac{(V_{B/A})_y}{(V_{B/A})_x} = 0.1565$

$\theta = 9.41°$

let us assume That it will leave The ground
Then $N = 0$ So $P\cos\alpha = \frac{mv^2}{\rho}$

$v^2 = \frac{\rho P\cos\alpha}{m} = \frac{100 \times 280 \times \cos 0}{280/32.2}$

(1)

$v^2 = 3220 \rightarrow v = 56.75$ ft/s

It is The minimum critical speed

be cleaner

(25) Problem ex. — let g The acceleration : $\Sigma F_y = m a_y = F$

The force That exist is The weight due the gravitational force between The center of mass for The rock and the earth

10000 km

$F = G \frac{m_{Earth}\, m_{rock}}{r^2}$

$r = 6378 + 10000 = 16378$ km

$F = \text{weight} = m_{rock}\, g$

So $g = \frac{G\, m_{earth}}{r^2} = \frac{G \times 5.974 \cdot 10^{24}}{(16378 \cdot 10^3)^2}$

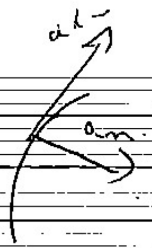
initial acceleration $g = 2.227 \cdot 10^{10}\, G$

good

When it dropped :

$\Sigma F_y = m a = F = G\, m_{earth}$

not necessary



$\vec{a}_A = \vec{0}$ (because V_A = cte).

$(a_n)_B = \frac{V^2}{\rho} = \frac{900^2}{200} = 4050$ Km/h²

$a_t = 200$ Km/h²

$\vec{a}_B = (200\cos 50\,\vec{i} + 200\sin 50\,\vec{j}) + (4050\cos 40\,\vec{i} - 4050\sin 40\,\vec{j})$

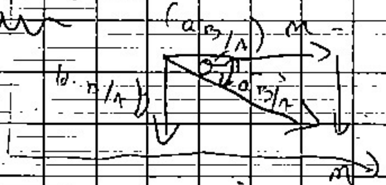
$= 3231.03\,\vec{i} - 2450.08\,\vec{j}$

$\vec{a}_{B/A} = \vec{a}_B - \vec{a}_A = \vec{a}_B$

magnitude of $\vec{a}_{B/A} = \sqrt{16441861}$

$= 4054.836$ Km/h²

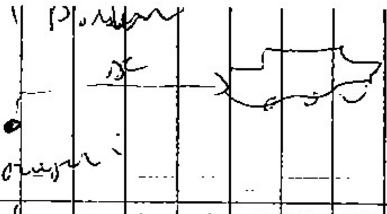
Direction



$\tan\theta = \frac{(a_{B/A})_y}{(a_{B/A})_x} = 0.758$

$\theta = 37.17°$

Problem 2:



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a) Motion for the car:

$V_c = cte = 50$ km/h

So $x_c = 0 + 50t = 50t$

Motion of my car (m): $a = 64$ km/h², we have $V_{0m} = 0$, $x_0 = 0$ So $V_m = V_{0m} + at = 0 + 64t$

$x_m = x_0 + V_{0m}t + \frac{1}{2}at^2 = \frac{1}{2}\times 64t^2$

at the time of overtaking the car and me will have

$x_c = x_m$

$50t = \frac{1}{2}\times 64t^2$ So $t = 0$ (at the initial position)

or $t = 1.56$ h

b) The distance traveled is traveled in 1.56 h

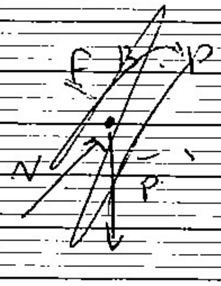
$x_{traveled} = 50 \times 1.56 = 78.125$ Km

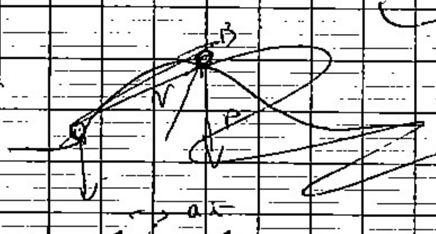
c) When the overtaking happened: $t = 1.56$ h

So $V_m = 64 \times 1.56 = 99.84$ Km/h

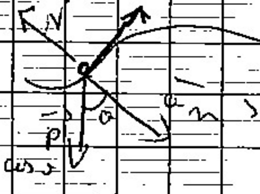
Problem 3:

(24)





$\Sigma F_n = m$



$\Sigma F_n = m a_n = m\frac{V^2}{\rho} = -N + P\cos\theta$

$\Sigma F_t = m a_t = -P\sin\theta$ ~~because V = cte~~

~~at~~ the top $V = cte$ so $a_t = 0$ ...