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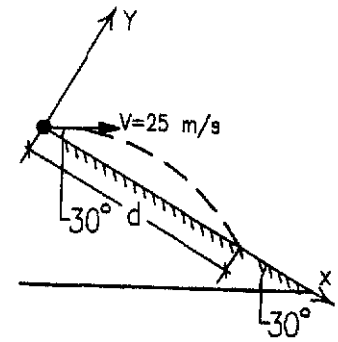
FACULTY OF ENGINEERING AND ARCHITECTURE
MECH 230 - DYNAMICS - QUIZ 1

NAME: **ID No:** **Mar. 15, 2008**

90 minutes closed book quiz
1- Solve the problems on the question sheets.
2- Write your solution in the given space.
3- Use the scratch booklet before writing on the question sheet.
4- The scratch booklet will not be collected and will not be graded.
5- Dirty paper will not be corrected.

No.1– (25%)

A ball is shot with a horizontal velocity of 25 m/s and lands on a straight hill inclined at 30°.



5% 1- Write the equation of the position of the ball along the indicated x-direction at any instant.

Solution:

5% 2- Write the equation of the position of the ball motion along the indicated y-direction at any instant.

Solution:

5% 3- Determine the time between take off and landing.

Solution:

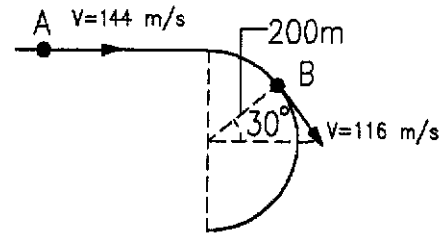
10% 4- Determine the length d where the ball hits the ground.

Solution:

NAME: **ID No:**

No.2– (25%)

Particle A is moving horizontally in a straight line, and its speed is being increased at a rate of 6 m/s^2. Particle B is moving horizontally along a circular path of 200 m radius. At the shown instant, the speed of B is being decreased at a rate of 2 m/s^2.



10% 1- Determine, for the position shown, the velocity of B relative to A.

Solution:

5% 2- Determine, for the position shown, the acceleration of B.

Solution:

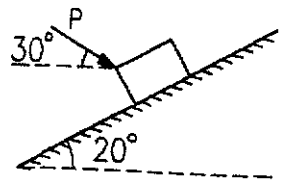
10% 3- Determine, for the position shown, the acceleration of B relative to A.

Solution

NAME: **ID No:**

No.3– (25%)

A 40 kg package is at rest on an incline when a constant force **P** is applied to it. 4 seconds is required for the package to travel 10 m up the incline. The kinetic coefficient of friction between the package and the incline is 0.25.



10% 1- Draw the free body diagram and the kinetic diagram of the package.

Solution

5% 2- Determine the acceleration of the package.

Solution

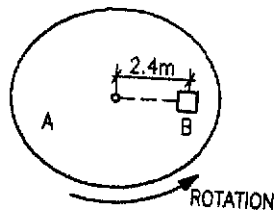
10% 3- Determine the magnitude of the force P.

Solution

NAME: **ID No:**

No.4– (25%)

A turntable A is built into a stage for use in a theatrical production. It is observed during a rehearsal that a 1 kg trunk B starts to slide on the turntable 12 seconds after the turntable begins to rotate. The trunk undergoes a constant tangential acceleration of 0.25 m/s^2.



10% 1- Draw the free body diagram and the kinetic diagram of the trunk.

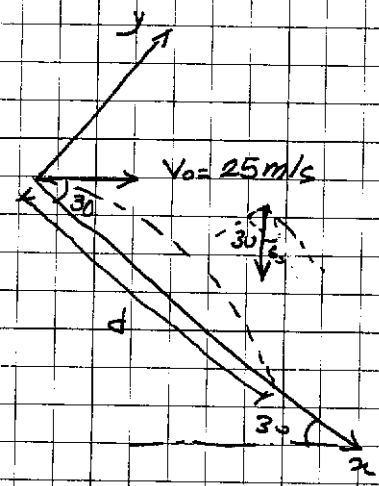
Solution

5% 2- Determine the speed of the trunk at t=12 s.

Solution

10% 3- Determine the coefficient of static friction between the trunk and the turntable.

Solution



• Motion along x - direction

$x = (0.5)(9.8\cos 60)t^2 + (25)(\cos 30)t$

$x = 2.4525\,t^2 + 21.65064\,t$

Motion along y - direction

$y = -(0.5)(9.8\cos 30)t^2 + (25)(\sin 30)t$

$y = -4.24785\,t^2 + 12.5\,t$

$y = 0 \Rightarrow \quad -4.24785\,t + 12.5 = 0 \Rightarrow t = 2.942665\,s$

$x = (2.4525)(2.942665)^2 + (21.65064)(2.942665) \Rightarrow d = 84.94746\,m$

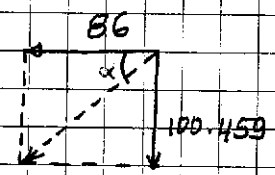
No. 2

1. $\vec{V}_{B/A} = \vec{V}_B - \vec{V}_A$

$V_{B/A_x} \rightarrow + V_{B/A_y} \downarrow = 116 \angle 60 - 144 \rightarrow$

$(\pm\rightarrow)$ $V_{B/A_x} = 116 \cos 60 - 144 = -86$ m/s

$(+\downarrow)$ $V_{B/A_y} = 116 \sin 60 - 0 = 100.4590$ m/s



$V_{B/A} = 132.2422 \angle 49.43$

2. $a_{B/n} = v^2/\rho = (116)^2/200 = 67.28$ m/s^2 $\angle 30$ $\quad a_t = 2$ m/s^2 $\angle 60$

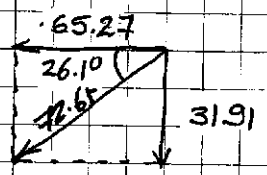
$\vec{a}_B = \vec{a}_{B_n} + a_{B_t} = 67.28 \angle 30 + 2 \angle 60 = 59.2662 \leftarrow + 31.9079 \downarrow = 67.3097 \angle 28.23$

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

$a_{B/A_x} \rightarrow + a_{B/A_y} \downarrow = 2$ m/s$^2 \angle 60 + 67.28 \angle 30 - 6 \rightarrow$

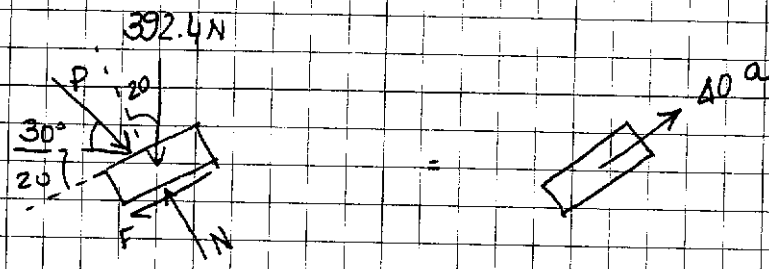
$(\pm\rightarrow)$ $a_{B/A_x} = -2 \cos 60 - 67.28 \cos 30 - 6 = -65.2662$ m/s^2

$(+\downarrow)$ $a_{B/A_y} = -2 \sin 60 + 67.28 \sin 30 - 0 = -31.9079$ m/s^2



$a_{B/A} = 72.6484$ m/s$^2 \angle 26.05$

$\mu_s = 0.30$ $\mu_k = 0.25$



$10 = (0.5)(a)t^2 + V_0 t + x_0$

$10 = (0.5)(a)(4)^2 \Rightarrow a = 1.25 \text{ m/s}^2$

$\rightarrow \Sigma F_x = ma \Rightarrow P\cos 50 - (392.4)(\cos 70) - (0.25)(N) = (40)(1.25)$

$+\uparrow \Sigma F_y = a \Rightarrow N - (392.4)(\cos 20) - (P)(\cos 40) = 0$

Hence $(P)(\cos 50) + (N)(-0.25) = [(40)(1.25) + (392.4\cos 70)]$

$(P)(-\cos 40) + (N)(1.0) = (392.4)(\cos 20)$

$P = 612.4683 \text{ N}$

$N = 837.9133 \text{ N} \Rightarrow F_k = (0.25)(837.9133) = 209.4783 \text{ N}$

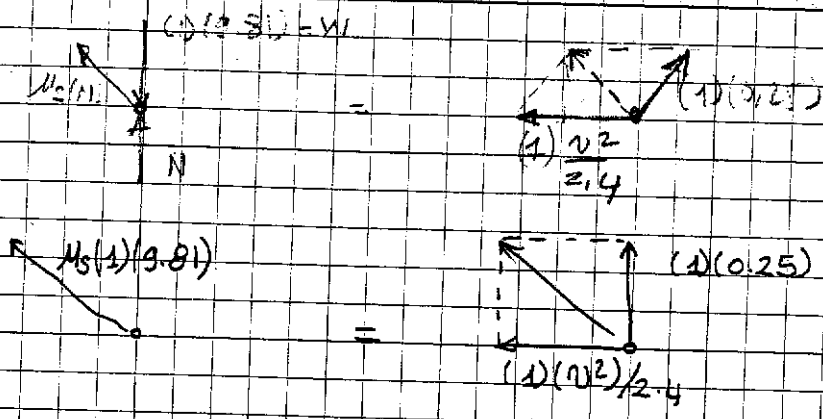
$F_s = (0.3)(837.9133) = 251.3740 \text{ N}$

Checking for motion

$(612.4683)(\cos 50) - (392.4)(\cos 70) = 259.4783 > 251.3740$

Hence motion occurs

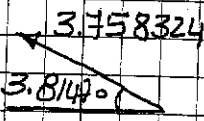
$m = 1\ kg$



$v = (0.25)(12) = 3\ m/s$

$a_n = (1)\dfrac{3^2}{2.4} = 3.75\ m/s^2$

$a = [0.25^2 + 3.75^2]^{1/2} = 3.758324\ m/s^2$



Hence $(\mu_s)(1)(9.81) = 3.758324 \Rightarrow \mu_s = 0.3831$