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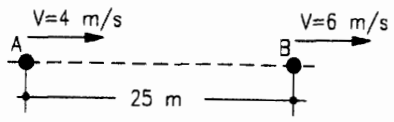
MECH 230 - DYNAMICS - QUIZ 1

NAME: **ID No:** **Mar. 20, 2010**

90 minutes open book
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%)

Particles A and B are moving along the straight line. At t=0 s particle A has a velocity of 4 m/s and a constant acceleration of 0.6 m/s^2. At t=0 s particle B has a velocity of 6 m/s and a constant deceleration of 0.4 m/s^2 and is located at 25 m from A as shown.



10% 1- Determine the instant of time when A meets B.

Solution:

10% 2- Determine the distance traveled by A at the instant it meets B.

Solution:

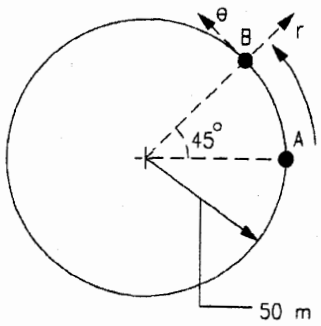
NAME: **ID No:**

5% 3- Determine the velocity of each particle at the instant they meet.

Solution:

No.2– (25%)

A Particle starts its motion from rest at A and moves counterclockwise along the circular path of radius 50 m. The particle increases its speed at a constant rate of 3 m/s^2.



10% 1- Determine the instant of time when the particle reaches point B as shown.

Solution:

5% 2- Determine the velocity of the particle at B.

Solution:

5 % 3- Determine the normal and tangential acceleration of the particle at B.

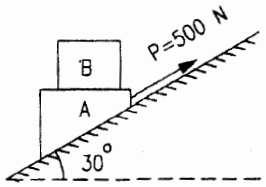
Solution

5 % 4- Determine the angular velocity $\dot{\theta}$ and the angular acceleration $\ddot{\theta}$ of the radial line representing the position of the particle at B at this instant.

Solution

No.3– (25%)

The 10-kg block B is supported by the 40-kg block A which is pulled up by the constant 500 N force parallel to the incline. Neglect friction between block A and the incline. Block B does not slip on block A



5% 1- Draw the free body diagrams and the kinetic diagrams of blocks A and B separately as well as A and B together.

Solution

10% 2- Determine the acceleration of the blocks.

Solution

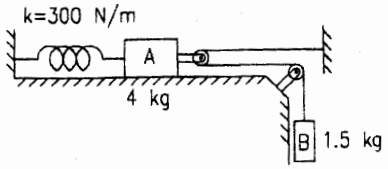
10% 3- Determine the minimum allowable value of the coefficient of static friction between the blocks so that slippage does not occur.

Solution

NAME: **ID No:**

No.4– (25%)

Blocks A and B have masses of 4 kg and 1.5 kg respectively, and are connected by a cord and pulley system and released from rest in the position shown with the spring undeformed. The spring constant is k=300 N/m and the kinetic coefficient of friction between block A and the ground is μ_k=0.1



5% 1- Draw the work free body diagrams of blocks A and B as one system.

Solution

10% 2- Determine the work of the friction force and the spring force on block A and the work of the weight of block B after block A has moved 0.1 m to the right.

Solution

10% 4- Determine the speed of block A after it has moved 0.1 m to the right.

Solution

USE FOR ANSWER

No. 1

A: $\vec{V_A} = 4\ m/s \rightarrow$ $\vec{a_A} = 0.6\ m/s^2 \rightarrow$

B: $V_B = 6\ m/s \rightarrow$ $\vec{a_B} = 0.4\ m/s^2 \leftarrow$

1- $S_A = (0.5)(0.6)t^2 + 4t$

$S_B = -(0.5)(0.4)t^2 + 6t + 25$

$S_A = S_B \rightarrow \quad 0.3t^2 + 4t = -0.2t^2 + 6t + 25$

$0.5t^2 - 2t - 25 = 0 \qquad t = 9.3485\ s$

2- $S_A = (0.5)(0.6)(9.3485)^2 + (4)(9.3485) = 63.6123\ m$

3- $V_A = (0.6)(9.3485) + 4 = 9.6091\ m/s \rightarrow$

$V_B = -(0.4)(9.3485) + 6 = 2.2606\ m/s \rightarrow$

USE FOR ANSWER

No. 2

1- $s = R\theta = (50)(\pi/4) = 39.2699\ m$

$v = a_t t \quad \& \quad s = \frac{1}{2} a_t t^2$

$39.2699 = (0.5)(3) t^2 \Rightarrow t = 5.1164\ s$

2- $v = (3)(5.1164) = 15.3492 \Rightarrow \vec{V} = 15.3492\ \angle 45$

3- $\vec{a}_t = 3\ m/s^2\ \angle 45$

$a_n = \frac{v^2}{\rho} = \frac{15.3492^2}{50} = 4.7120\ m/s^2 \Rightarrow \vec{a}_n = 4.7120\ \angle 45$

4. $r = 50\ m \qquad \theta = \pi/4$

$\dot{r} = 0\ m/s \qquad \dot{\theta} =$

$\ddot{r} = 0\ m/s^2 \qquad \ddot{\theta} =$

$v_\theta = r\dot{\theta} \Rightarrow 15.3492 = (50)\dot{\theta} \Rightarrow \dot{\theta} = 0.3070\ rad/s$

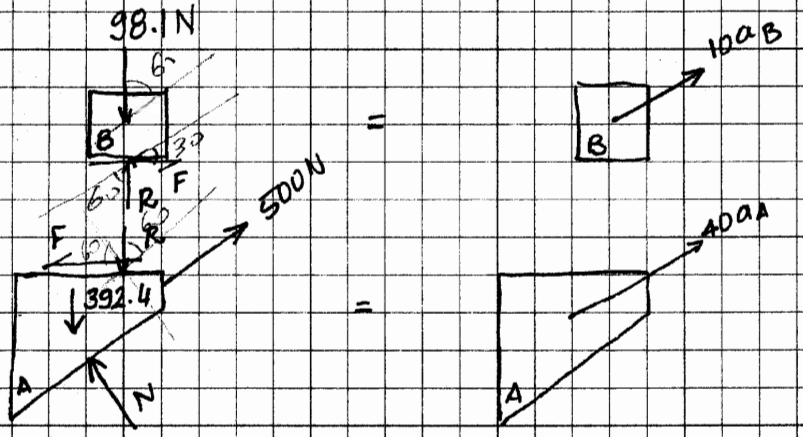
$a_r = \ddot{r} - r\dot{\theta}^2 \Rightarrow -4.7120 = 0 - (50)(\dot{\theta})^2 \Rightarrow \dot{\theta} = 0.3070\ rad/s$

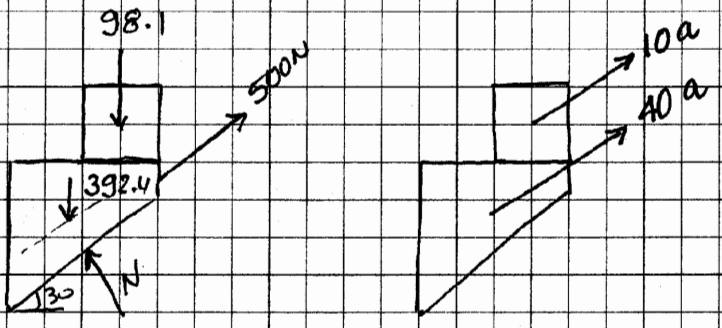
$a_\theta = (r\ddot{\theta} + 2\dot{r}\dot{\theta}) \Rightarrow 3 = (50)\ddot{\theta} + 0 \Rightarrow \ddot{\theta} = 0.06\ rad/s^2$

No.3

$m_B = 10\ kg$ $m_A = 40\ kg$ $P = 500\ N$

1-





2- $(\rightarrow)\ \Sigma F = ma \Rightarrow -(98.1)(\cos 60) - (392.4)(\cos 60) + 500 = 10a + 40a$

$\Rightarrow \overline{a} = 5.095\ m/s^2\ \angle 30°$

3- Block B $(\rightarrow)\ \Sigma F_x = ma_x \Rightarrow F\cos 30 + R\cos 60 - 98.1\cos 60 = (10)(5.095)$

$(\uparrow)\ \Sigma F_y = ma_y \Rightarrow R\cos 30 - F\sin 30 - 98.1\cos 30 = 0$

$R = 123.575\ N$

$F = 44.1240\ N$ $\Big\} \mu_k = 0.3570$

OR BLOCK A $(\rightarrow)\ \Sigma F_x = ma_x$ $500 - (392.4)(\cos 60) - R\cos 60 - F\cos 30 = (40)(5.095)$

$(\uparrow)\ \Sigma F_y = ma_y$ $N - (392.4)(\cos 30) + F\cos 60 - R\cos 30 = 0$

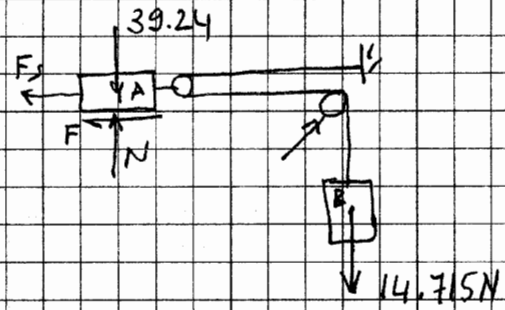
$\Rightarrow N = 424.7855\ N$

OR Combined $N = (98.1)(\cos 30) + (392.4)(\cos 30) = 424.7855\ N$

No.4

$m_A = 4\,kg$ $m_B = 1.5\,kg$ $k = 300\,N/m$ $\mu_k = 0.1$

1-



2- $N = 39.24\,N \Rightarrow F = (0.1)(39.24) = 3.924\,N \Rightarrow U_{1-2} = -(0.1)(3.924) = -0.3924$

Spring $U_{1-2} = -(0.5)(300)(0.1)^2 = -1.5\,J$

Weight of block B: $U_{1-2} = (2)(0.1)(14.715) = 2.943\,J$

3- $T_1 + \Sigma U_{1-2} = T_2$ & $|V_B| = |2V_A|$

$0 + 2.943 - 1.5 - 0.3924 = (0.5)(4)(V_A)^2 + (0.5)(1.5)(2V_A)^2 \Rightarrow V_A = 0.4584\,m/s$