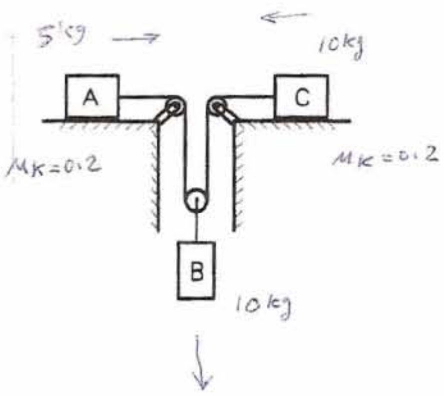
PREVIOUS QUIZ SOLUTION DYNAMICS

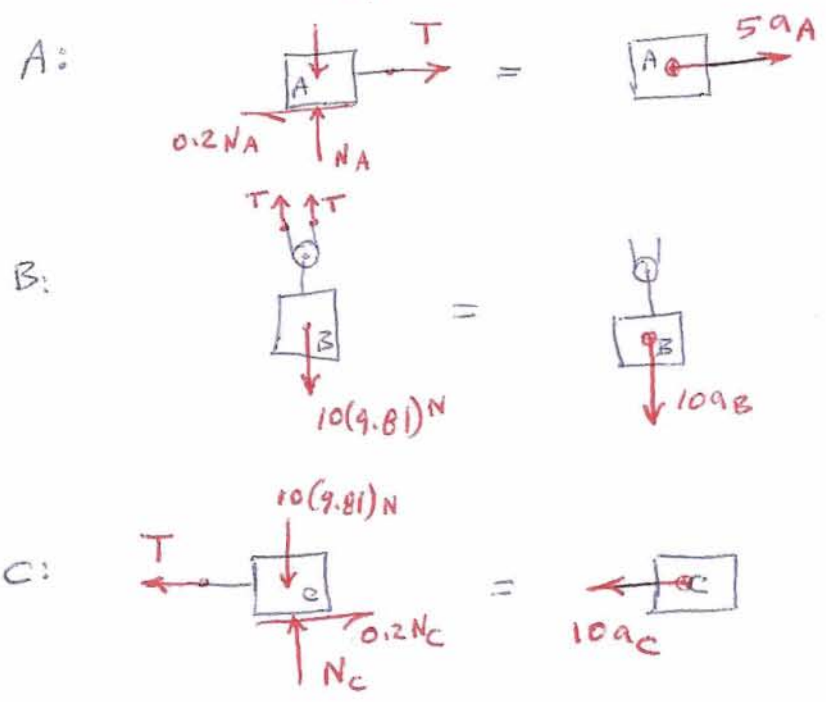
No.1– (~~25%~~) 20%

Consider block A of 5 kg, block B of 10 kg, and block C of 10 kg attached by the rope as shown in the figure. All the blocks are in motion. The coefficient of kinetic friction between blocks A and C and the horizontal surface μ_k=0.2



5% 1- Draw the free body diagrams and kinetic diagrams of blocks A, B, and C.

Solution:



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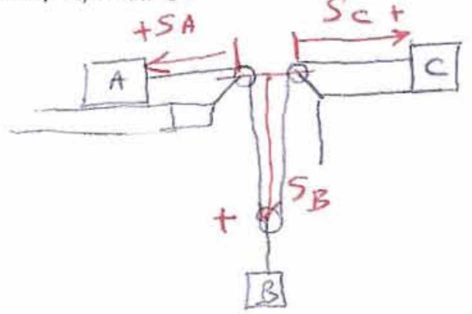
5% 2- Write the Constraint equation relating the accelerations of blocks A, B, and C.



Solution:

$s_A + 2s_B + s_C = \text{Constant}$

time derivative $v_A + 2v_B + v_C = 0$

$$\boxed{\vec{a}_A + 2\vec{a}_B + \vec{a}_C = \vec{0}}$$

Based on the assumption of F.B.D.

$$\boxed{-a_A + 2a_B - a_C = 0}$$

5% 3- Apply Newton 2nd Law – **F=ma** – on blocks A, B, and C.

Solution:

A: $\xrightarrow{+} \Sigma F_x = ma_x$; $\xrightarrow{+}$ $T - \overbrace{0.2(5)(9.81)}^{9.81} = 5a_A$; $\Sigma F_y = 0$; $N_A = 5(9.81)$ N

B: $+\uparrow \Sigma F_y = ma_y$; $2T - 981 = 10a_B$

C: $\xleftarrow{+} \Sigma F_x = ma_x$; $T - \underbrace{0.2(10)(9.81)}_{19.62} = 10a_C$; $\Sigma F_y = 0$; $N_C = 981$ N

$$T - 5a_A = 9.81$$
$$2T + 10a_B = 981$$
$$T - 10a_C = 19.62$$

5% 4- Determine the acceleration of each block and the tension in the rope.

Solution:

$$\begin{array}{ccccccc} & 1 & 2 & 3 & 4 & & \\ & \square & -a_A & +2a_B & -a_C & = & 0 \\ & T & -5a_A & & & = & 9.81 \\ & 2T & & 10a_B & & = & 981 \\ & T & & & -10a_C & = & 19.62 \end{array}$$

$T = 285.89$ N

$a_A = 55.216\ m/s^2$

$a_B = 40.922\ m/s^2$

$a_C = 26.627\ m/s^2$

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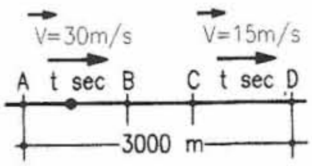
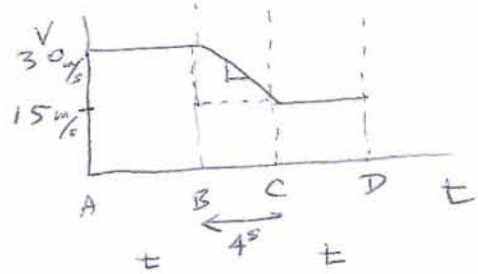
No.2– ($\cancel{25}$%) 20%

In traveling a distance of 3000 m between points A and D, a particle is driven at 30 m/s from A to B for **t** seconds and at 15 m/s from C to D for **t** seconds. The particle uniformly decelerates for 4 seconds between B and C.



5% 1- Determine the deceleration of the particle in the interval BC.



Solution

$\overset{+}{\rightarrow}\quad V_C^2 - V_{o_B}^2 = 2a_C\,\Delta S_{BC}$

$(15)^2 - (30)^2 = 2(a_c)\Delta S_{ABC}$

$s = s_o + V_o t\ ;\ s_{AB} = 30t$

$s_{CD} = 15t$

$s_{AB} + s_{BC} + s_{CD} = 3000\,m$

$\overset{+}{\rightarrow}\quad \Delta S_{BC} = V_B t_{BC} + \frac{1}{2}a_c t_{BC}^2$

$\Delta S_{BC} = 30\underset{(4)}{\cancel{t}} - \frac{a_c}{2}(4)^2$

$V_c = V_B + a_c(4)$ $\qquad a_c = \frac{15-30}{4}$

$15 = 30 + a_c(4)\ ;\ a_c = -3.75\,m/s^2$ Ans.

5% 2- Determine the distance between B and C.

Solution:

$\Delta S_{BC} = \overset{S_{AB}}{30(4)} - \frac{3.75}{2}(4)^2 = 90\,m$

or: $15^2 - 30^2 = 2(-3.75)\,\Delta S_{BC}\ ;\ \boxed{\Delta S_{BC} = 90\ m}$ Ans.

5% 3- Determine the time **t** in seconds.

Solution: $t + 4 + t = t_{AD}$

$S_{AB} + S_{BC} + S_{CD} = 3000$

$30t + 90 + 15t = 3000.\ ;\ 45t = 2910$

$t = \frac{2910}{45} = \underline{\underline{64.67\ s}}$ Ans.

5% 4- Determine the distances between AB and CD.

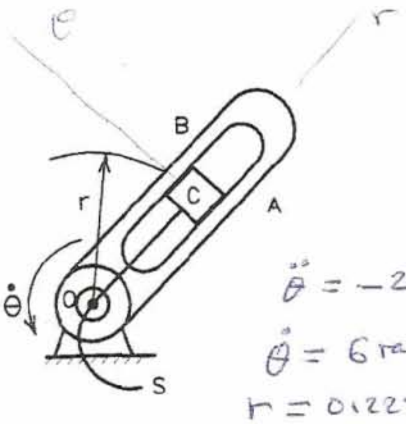
Solution:

$$s_{AB} = 30t = 30(64.67) = \underline{1940.1\ m} \quad Ans.$$

$$s_{CD} = 15t = 15(64.67) = \underline{970.05\ m} \quad Ans.$$

No.3– (20%)

The slotted arm revolves in the **horizontal** plane about the fixed vertical axis through point O. The 2 kg slider C is drawn towards O at the constant rate of 0.05 m/s by pulling the cord S. At the instant for which r=0.225 m, the arm has a counterclockwise angular velocity at 6 rad/s and is slowing down at the rate of 2 rad/s^2. The slider moves in the smooth slotted arm.



$\ddot{\theta} = -2\ rad/s^2$

$\dot{\theta} = 6\ rad/s$

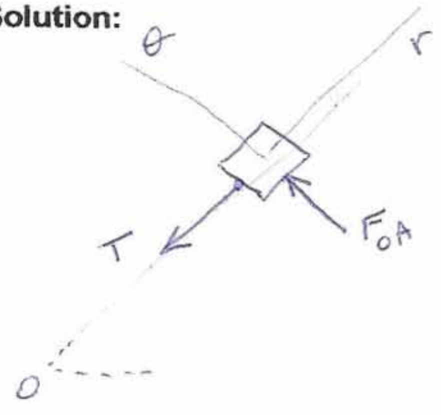
$r = 0.225\ m$

$\dot{r} = -0.05\ m/s$

$m = 2\ kg$

10% 1- Draw the free body diagram and the kinetic diagram of the slider C in the position shown.

Solution:



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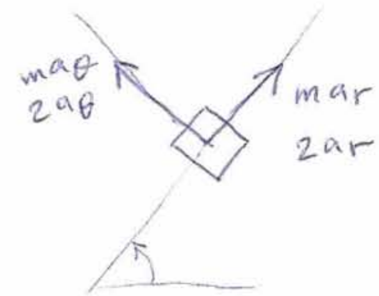

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5% 2- Determine the radial and the transverse component of acceleration of the slider for the position shown.

Solution:

$r = 0.225\ m$

$\dot{r} = -0.05\ m/s$ = Constant

$\ddot{r} = 0$

$\dot{\theta} = 6\ rad/s$

$\ddot{\theta} = -2\ rad/s^2$

$a_r = \cancel{\ddot{r}}^{\,0} - r\dot{\theta}^2 = -0.225(6^2)$

$\boxed{a_r = -8.1\ m/s^2}$

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$

$= 0.225(-2) + 2(-0.05)(6)$

$= -1.015$

$\boxed{a_\theta = -1.05\ m/s^2}$

5% 3- For the position shown, determine the magnitude of the force exerted on the slider by the side of the smooth radial slot and determine the magnitude of the tension force in the cord.

Solution:

m

$\overset{+}{\nearrow} \Sigma F_r = m a_r$

$-T = 2a_r$

$-T = 2(-8.1)$

$\underline{T = 16.2\ N}$ Ans.

$\overset{+}{\nwarrow} \Sigma F_\theta = m a_\theta$

$F_{OA} = 2a_\theta$

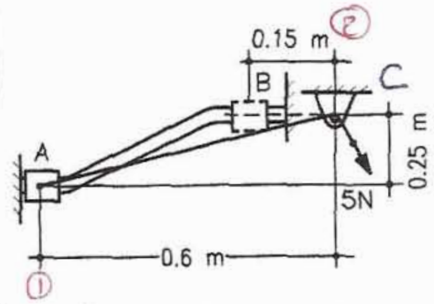
$F_{OA} = 2(-1.05)$

$\underline{\underline{F_{OA} = -2.1\ N}}$ Ans.

NAME: **ID No:**

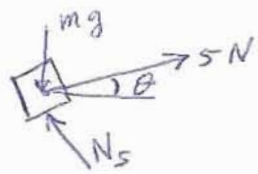
No.4– (20%)

The 0.2 kg slider moves freely along the fixed curved rod from A to B in the vertical plane under the action of the constant 5 N tension in the ~~curve~~. The slider is released from rest at ~~B~~. A Cable



5% 1- Draw the free body diagram of the slider for an intermediate position between A and B.

Solution:



5% 2- Determine the work of the weight on the slider for the motion from A to B.

Solution:

$$U_{1-2\,W} = -mg\,\Delta Y = -0.2(9.81)(0.25^{m})$$
$$= -0.4905\ \text{J} \quad \text{Ans.}$$

10% 2- Determine the velocity of the slider when it reaches B.

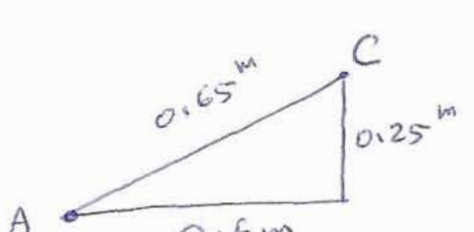
Solution:

$$T_1 + \Sigma U_{1-2} = T_2$$

$T_1 = 0$ rest

$$T_2 = \frac{1}{2} m V^2 = \frac{1}{2}(0.2)\,v^2 = 0.1\,V^2$$

$$\Sigma U_{1-2} = -0.4905^{J} + (5^{N})(\Delta \ell)$$
$$= -0.4905 + 5(0.5) = 2.0095\ \text{J}$$



$\overline{AC} = 0.65^{m}$

$\overline{BC} = 0.15^{m}$

$\Delta \ell = \overline{AC} - \overline{BC} = 0.5^{m}$

$\therefore\ 0 + 2.01 = 0.1\,V^2 \quad ; \quad V^2 = 20.1$

$$V = 4.483\ \text{m/s} \quad \text{Ans.}$$

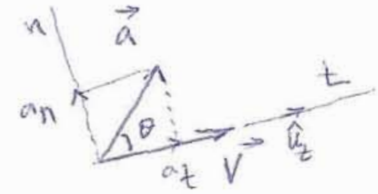
NAME: **ID No:**

No.5– (20%)

The velocity and acceleration of a particle are given, for a certain instant, by **v**= (6**i** - 3**j** + 2**k**) m/s and **a**= (3**i** - 1**j** + 5**k**) m/s^2.

$V = 7$ $\qquad a = 5.9161$

10% 2- Determine the angle between the velocity and the acceleration.



Solution: $\vec{a} \cdot \vec{V} = a\,V \cos\theta$

$$(3\hat{i} - 1\hat{j} + 5\hat{k}) \cdot (6\hat{i} - 3\hat{j} + 2\hat{k}) = (5.9161)(7) \cos\theta$$

$$18 + 3 + 10 = 31 = (5.9161)(7) \cos\theta$$

$$\cos\theta = \frac{31}{(5.9161)(7)} = 0.7486$$

$$\theta = \cos^{-1}(0.7486)$$

$$\boxed{\theta = 41.53^\circ}$$

5% 2- Determine the magnitude of the tangential acceleration.

Solution: $a_t = a \cos\theta = 5.9161 \cos 41.53^\circ$

$= \underline{4.429 \text{ m/s}^2}$ Ans.

$$\hat{u}_t = \frac{6}{7}\hat{i} - \frac{3}{7}\hat{j} + \frac{2}{7}\hat{k}$$

$$|\vec{a}_t| = \vec{a} \cdot \hat{u}_t = (3\hat{i} - \hat{j} + 5k) \cdot \left(\frac{6}{7}\hat{i} - \frac{3}{7}\hat{j} + \frac{2}{7}\hat{k}\right)$$

$$= \frac{3 \times 6}{7} + 3/7 + \frac{10}{7} = \underline{\underline{4.429}} \text{ m/s}^2 \text{ Ans.}$$

5% 3- Determine the magnitude of the normal acceleration.

Solution:

$$a_n = a \sin\theta = 5.9161 \sin 41.53^\circ$$

$$a_n = \underline{\underline{3.922}} \text{ m/s}^2 \text{ Ans.}$$

$$\vec{a}_t = \overset{a_t}{4.429} \overset{\hat{u}_t}{\left(\frac{6}{7}\hat{i} - \frac{3}{7}\hat{j} + \frac{2}{7}\hat{k}\right)} = 3.796\hat{i} - 1.898\hat{j} + 1.265\hat{k} \text{ m/s}^2$$

$$\vec{a}_n = \vec{a} - \vec{a}_t = 3\hat{i} - \hat{j} + 5\hat{k}$$
$$- 3.796\hat{i} + 1.898\hat{j} - 1.265\hat{k}$$
$$= -0.796\hat{i} + 0.898\hat{j} + 3.735\hat{k}$$

$$a_n = |\vec{a}_n| = \underline{3.923} \text{ m/s}^2 \text{ Ans.}$$