BAU-FE-MED

Dynamics- Final Exam-Jan-2013

Student Name: ______________________

د. مليحات اللوباني

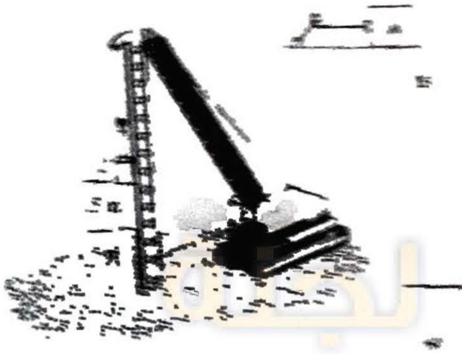
Instructor name: 3"30-5

Select the right answer for each question below:

Q1: In the pulley system shown aside ($m_A = 0.5\ m_B$). Neglecting friction and pulleys mass which of the following is true:

→ (a-) block ***B*** will experience a larger acceleration magnitude than block ***A***.
b- block ***B*** will experience an equal acceleration magnitude to block ***A***.
c- block ***B*** motion has no specific relation to that of block ***A***.
d- block ***A*** will experience a larger acceleration magnitude than block ***B***.

Q2 The pile *P* has a mass of **800** kg and is being driven into *loose sand* using the **400**-kg hammer *C* which is dropped a distance of **0.5** m from the top of the pile. Determine the initial speed(m/s) of the pile just after it is struck by the hammer. The coefficient of restitution between the hammer and the pile **e=0.3**. Neglect the impulses due to the weights of the pile and hammer and the impulse due to the sand during the impact.



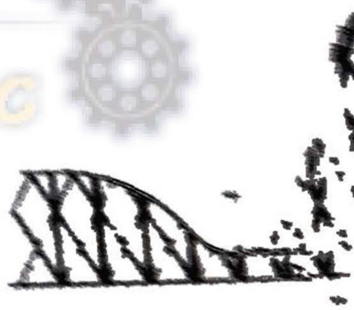
b) 0.94 b) 0.626 c) 1.25 (d) 1.35)

Q3: The **4.5**-Mg engine is suspended from a spreader beam *AB* having a negligible mass and is hoisted by a crane which gives it an acceleration of **4** m/s² when it has a velocity of **4** m/s. Determine the force(N) in chains *CB* and *CA* during the lift.

(a) 35879) b) 38500 c) 41075 d) 71145

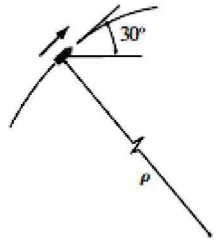
Q4: Roller coasters are designed so that riders will not experience a normal force that is more than 4.5 times their weight against the seat of the car. Determine the smallest radius of curvature ρ (m) of the track at its lowest point if the car has a speed of 10 m/s at the crest of the drop. Neglect friction.

a) 88.3 b) 92.07 c) 65.77 d) 2258.2



Q5: If bar AB has an angular velocity $\omega_{AB} = 3$ rad/s, determine the velocity of the slider block C at the instant shown.

13–50. At the instant shown, the 50-kg projectile travels in the vertical plane with a speed of $v = 40$ m/s. Determine the tangential component of its acceleration and the radius of curvature ρ of its trajectory at this instant.



Free-Body Diagram: The free-body diagram of the projectile is shown in Fig. (a). Here, $\mathbf{a}_n$ must be directed towards the center of curvature of the trajectory (positive n axis).

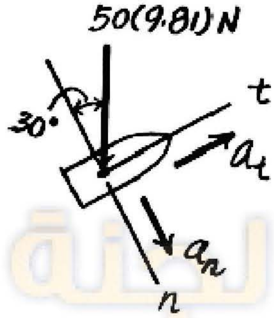
Equations of Motion: Here, $a_n = \dfrac{v^2}{\rho} = \dfrac{40^2}{\rho}$. By referring to Fig. (a),

$+\nearrow \Sigma F_t = ma_t;$ $\qquad -50(9.81)\sin 30° = 50a_t$

$a_t = -4.905 \text{ m/s}^2$ **Ans.**

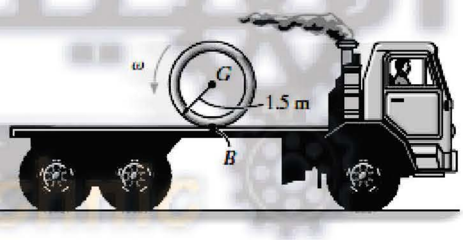
$+\searrow \Sigma F_n = ma_n;$ $\qquad 50(9.81)\cos 30° = 50\left(\dfrac{40^2}{\rho}\right)$

$\rho = 188$ m **Ans.**



(a)

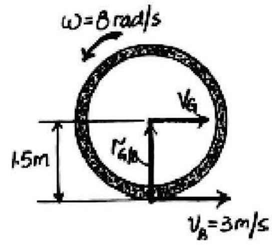
16–74. At the instant shown, the truck travels to the right at 3 m/s, while the pipe rolls counterclockwise at $\omega = 8$ rad/s without slipping at B. Determine the velocity of the pipe's center G.



$\mathbf{v}_G = \mathbf{v}_B + \mathbf{v}_{G/B}$

$\left[\underset{\rightarrow}{v_G}\right] = \left[\underset{\rightarrow}{3}\right] + \left[\underset{\leftarrow}{1.5(8)}\right]$

$v_G = 9$ m/s $\leftarrow$ **Ans.**



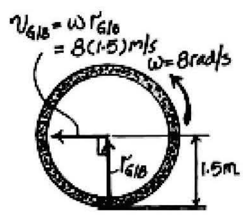
Also:

$\mathbf{v}_G = \mathbf{v}_B + \boldsymbol{\omega} \times \mathbf{r}_{G/B}$

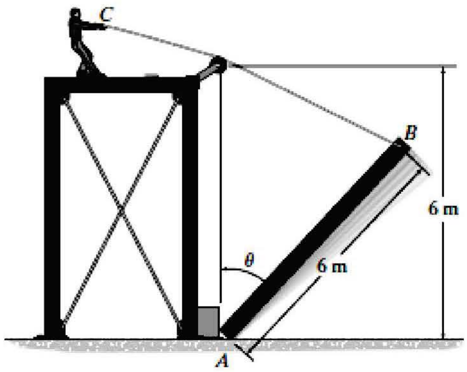
$v_G\mathbf{i} = 3\mathbf{i} + (8\mathbf{k}) \times (1.5\mathbf{j})$

$v_G = 3 - 12$

$v_G = -9$ m/s $= 9$ m/s $\leftarrow$ **Ans.**



***16–48.** The man pulls on the rope at a constant rate of 0.5 m/s. Determine the angular velocity and angular acceleration of beam AB when $\theta = 60°$. The beam rotates about A. Neglect the thickness of the beam and the size of the pulley.



Position Coordinates: Applying the law of cosines to the geometry,

$$s^2 = 6^2 + 6^2 - 2(6)(6)\cos\theta$$

$$s^2 = \left(72 - 72\cos\theta\right)\text{m}^2$$

Time Derivatives: Taking the time derivative,

$$2s\dot{s} = 0 - 72\left(-\sin\theta\dot{\theta}\right)$$

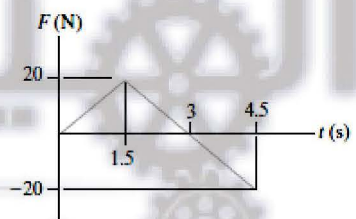
$$s\dot{s} = 36\sin\theta\dot{\theta} \qquad \textbf{(1)}$$

Here, $\dot{s} = -0.5$ m/s since $\dot{s}$ acts in the negative sense of s. When $\theta = 60°$, $s = \sqrt{72 - 72\cos 60°} = 6$ m. Thus, Eq. (1) gives

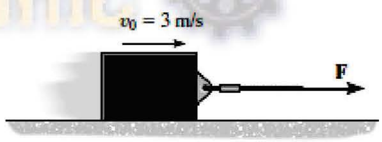
$$6\left(-0.5\right) = 36\sin 60°\dot{\theta}$$

$$\omega = \dot{\theta} = -0.09623\,\text{rad/s} - 0.0962\text{ rad/s} \qquad \textbf{Ans.}$$

15–14. The 10-kg smooth block moves to the right with a velocity of $v_0 = 3$ m/s when force **F** is applied. If the force varies as shown in the graph, determine the velocity of the block when $t = 4.5$ s.



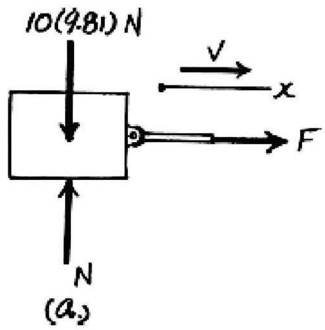
Principle of Impulse and Momentum: The impulse generated by force **F** during $0 \le t \le 4.5$ is equal to the area under the **F** vs. t graph, i.e., $I = \int F dt = \frac{1}{2}(20)(3 - 0) + \left[-\frac{1}{2}(20)(4.5 - 3)\right] = 15\,\text{N}\cdot\text{s}$. Referring to the free-body diagram of the block shown in Fig. a,



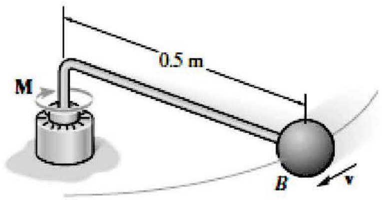
$$\left(\overset{+}{\rightarrow}\right) \qquad m\left(v_1\right)_x + \Sigma\int_{t_1}^{t_2} F_x\, dt = m\left(v_2\right)_x$$

$$10(3) + 15 = 10v$$

$$v = 4.50\text{ m/s} \qquad \textbf{Ans.}$$



***15–96.** The ball B has a mass of 10 kg and is attached to the end of a rod whose mass can be neglected. If the shaft is subjected to a torque $M = (2t^2 + 4)$ N · m, where t is in seconds, determine the speed of the ball when $t = 2$ s. The ball has a speed $v = 2$ m/s when $t = 0$.

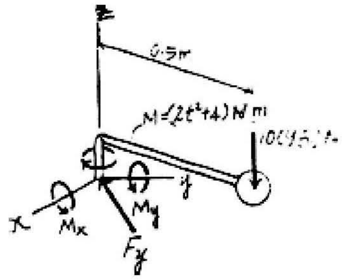


Principle of Angular Impluse and Momentum: Applying Eq. 15–22, we have

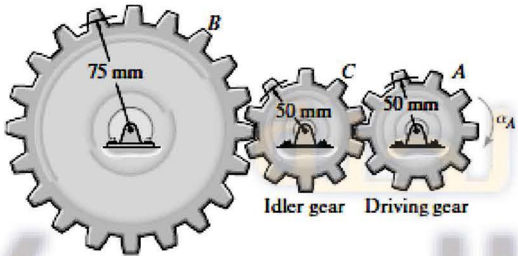
$$(H_z)_1 + \Sigma \int_{t_1}^{t_2} M_z\,dt = (H_z)_2$$

$$0.5(10)(2) + \int_0^{2\,s} \left(2t^2 + 4\right) dt = 0.5(10)\,v$$

$$v = 4.67 \text{ m/s} \qquad \textbf{Ans.}$$



•16–9. When only two gears are in mesh, the driving gear A and the driven gear B will always turn in opposite directions. In order to get them to turn in the *same direction* an idler gear C is used. In the case shown, determine the angular velocity of gear B when $t = 5$ s, if gear A starts from rest and has an angular acceleration of $\alpha_A = (3t + 2)$ rad/s², where t is in seconds.



$$d\omega = \alpha\,dt$$

$$\int_0^{\omega_A} d\omega_A = \int_0^t (3t + 2)\,dt$$

$$\omega_A = 1.5t^2 + 2t|_{t=5} = 47.5 \text{ rad/s}$$

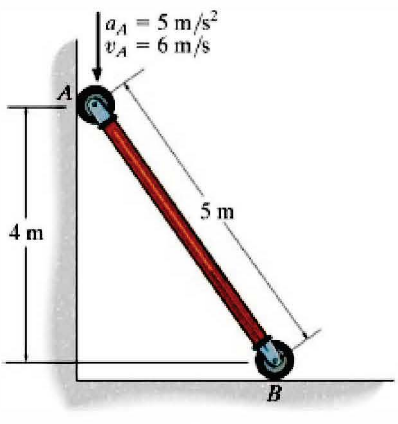
$$(47.5)(50) = \omega_C\,(50)$$

$$\omega_C = 47.5 \text{ rad/s}$$

$$\omega_B\,(75) = 47.5(50)$$

$$\omega_B = 31.7 \text{ rad/s} \qquad \textbf{Ans.}$$

F16–19. At the instant shown, end A of the rod has the velocity and acceleration shown. Determine the angular acceleration of the rod and acceleration of end B of the rod.



F16–19

F16–19. $\omega = \dfrac{v_A}{r_{A/IC}} = \dfrac{6}{3} = 2$ rad/s

$$\mathbf{a}_B = \mathbf{a}_A + \boldsymbol{\alpha} \times \mathbf{r}_{B/A} - \omega^2 \mathbf{r}_{B/A}$$

$$a_B\mathbf{i} = -5\mathbf{j} + (\alpha\mathbf{k}) \times (3\mathbf{i} - 4\mathbf{j}) - 2^2(3\mathbf{i} - 4\mathbf{j})$$

$$a_B\mathbf{i} = (4\alpha - 12)\mathbf{i} + (3\alpha + 11)\mathbf{j}$$

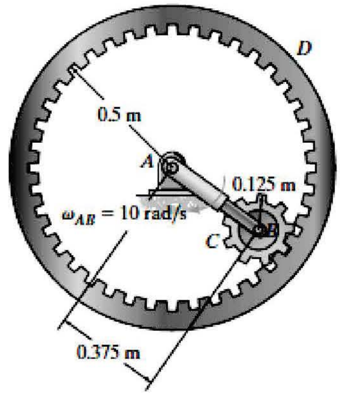
$$a_B = 4\alpha - 12$$

$$0 = 3\alpha + 11$$

$$\alpha = -3.67 \text{ rad/s}^2 \qquad \textit{Ans.}$$

$$a_B = -26.7 \text{ m/s}^2 \qquad \textit{Ans.}$$

16–79. If the ring gear D is held fixed and link AB rotates with an angular velocity of $\omega_{AB} = 10$ rad/s, determine the angular velocity of gear C.



Rotation About a Fixed Axis: Since link AB rotates about a fixed axis, Fig. a, the velocity of the center B of gear C is

$$v_B = \omega_{AB} r_{AB} = 10(0.375) = 3.75 \text{ m/s}$$

General Plane Motion: Since gear D is fixed, the velocity of the contact point P between the gears is zero. Applying the relative velocity equation and referring to the kinematic diagram of gear C shown in Fig. b,

$$\mathbf{v}_B = \mathbf{v}_P + \boldsymbol{\omega}_C \times \mathbf{r}_{B/P}$$

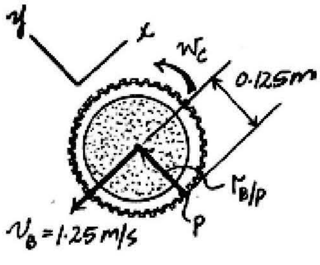
$$-3.75\mathbf{i} = \mathbf{0} + (\omega_C \mathbf{k}) \times (0.125\mathbf{j})$$

$$-3.75\mathbf{i} = -0.125\omega_C\mathbf{i}$$

Thus,

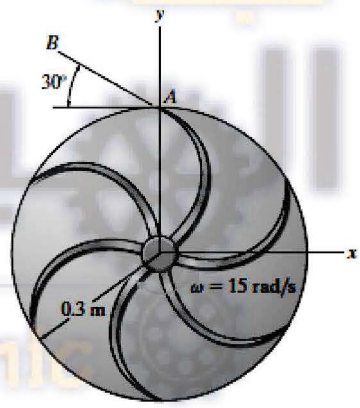
$$-3.75 = -0.125\omega_C$$

$$\omega_C = 30 \text{ rad/s} \qquad \textbf{Ans.}$$



(a)

16–155. Water leaves the impeller of the centrifugal pump with a velocity of 25 m/s and acceleration of 30 m/s^2, both measured relative to the impeller along the blade line AB. Determine the velocity and acceleration of a water particle at A as it leaves the impeller at the instant shown. The impeller rotates with a constant angular velocity of $\omega = 15$ rad/s.



Reference Frame: The xyz rotating reference frame is attached to the impeller and coincides with the XYZ fixed reference frame at the instant considered, Fig. a. Thus, the motion of the xyz frame with respect to the XYZ frame is

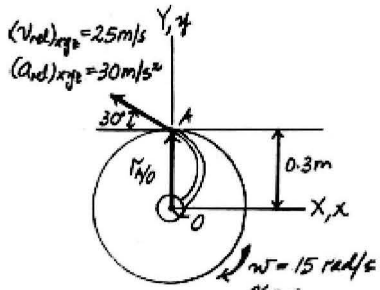
$$\mathbf{v}_O = \mathbf{a}_O = \mathbf{0} \qquad \boldsymbol{\omega} = [-15\mathbf{k}] \text{ rad/s} \qquad \dot{\boldsymbol{\omega}} = \mathbf{0}$$

The motion of point A with respect to the xyz frame is

$$\mathbf{r}_{A/O} = [0.3\mathbf{j}] \text{ m}$$

$$(\mathbf{v}_{rel})_{xyz} = (-25\cos 30°\mathbf{i} + 25\sin 30°\mathbf{j}) = [-21.65\mathbf{i} + 12.5\mathbf{j}] \text{ m/s}$$

$$(\mathbf{a}_{rel})_{xyz} = (-30\cos 30°\mathbf{i} + 30\sin 30°\mathbf{j}) = [-25.98\mathbf{i} + 15\mathbf{j}] \text{ m/s}^2$$



(a)

Velocity: Applying the relative velocity equation.

$$\mathbf{v}_A = \mathbf{v}_O + \boldsymbol{\omega} \times \mathbf{r}_{A/O} + (\mathbf{v}_{rel})_{xyz}$$

$$= \mathbf{0} + (-15\mathbf{k}) \times (0.3\mathbf{j}) + (-21.65\mathbf{i} + 12.5\mathbf{j})$$

$$= [-17.2\mathbf{i} + 12.5\mathbf{j}] \text{ m/s} \qquad \textbf{Ans.}$$

Acceleration: Applying the relative acceleration equation,

$$\mathbf{a}_A = \mathbf{a}_O + \dot{\boldsymbol{\omega}} \times \mathbf{r}_{A/O} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}_{A/O}) + 2\boldsymbol{\omega} \times (\mathbf{v}_{rel})_{xyz} + (\mathbf{a}_{rel})_{xyz}$$

$$= \mathbf{0} + (-15\mathbf{k}) \times [(-15\mathbf{k}) \times (0.3\mathbf{j})] + 2(-15\mathbf{k}) \times (-21.65\mathbf{i} + 12.5\mathbf{j}) + (-25.98\mathbf{i} + 15\mathbf{j})$$

$$= [349\mathbf{i} + 597\mathbf{j}] \text{ m/s}^2 \qquad \textbf{Ans.}$$

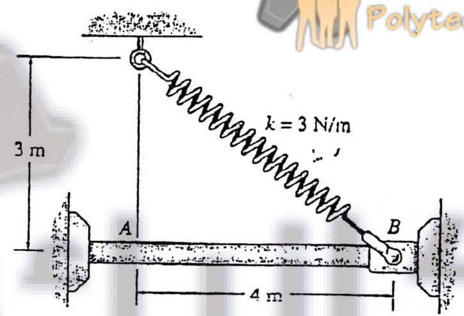
AL-Balqa Applied University
Faculty of Engineering Technology

Mechanical department

Final exam – Dynamics
2008-2009
Dr. Salameh Swalha

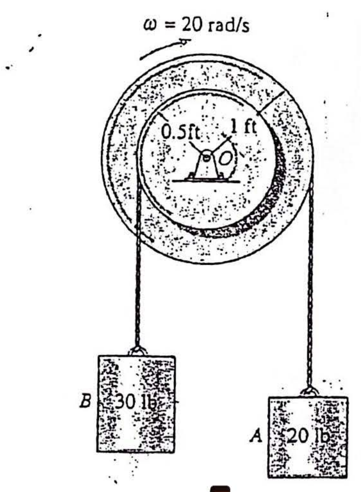
Q1 (12 point)

The 2-kg collar is attached to a spring that has an unstretched length of 3 m. If the collar is drawn to point B and released from rest, determine its speed when it arrives at point A.



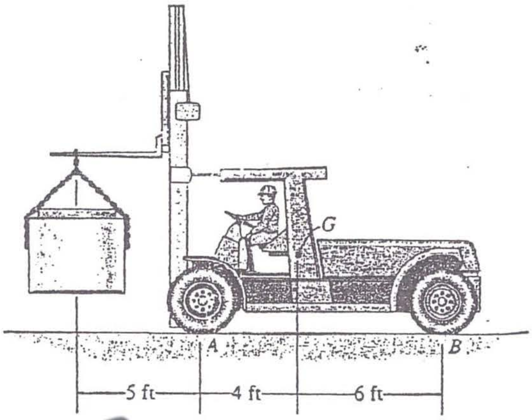
Q2(13 point)

The double pulley consists of two parts that are attached to one another. It has a weight of 50 lb and a centroidal radius of gyration of $k_O = 0.6$ ft and is turning with an angular velocity of 20 rad/s clockwise. Determine the kinetic energy of the system. Assume that neither cable slips on the pulley.



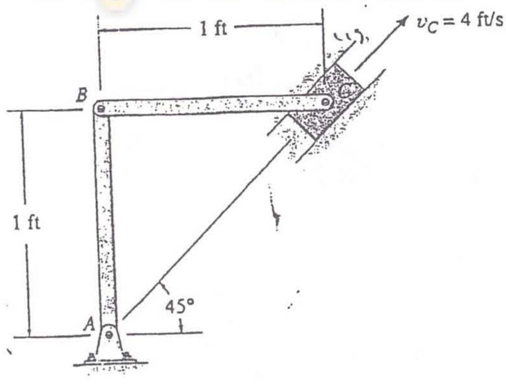
Q3 (13 point)

The forklift and operator have a combined weight of 10 000 lb and center of mass at G. If the forklift is used to lift the 2000-lb concrete pipe, determine the normal reactions on each of its four wheels if the pipe is given an upward acceleration of 4 ft/s^2.



Q4(12 point)

The velocity of the slider block C is 4 ft/s up the inclined groove. Determine the angular velocity of links AB and BC and the velocity of point B at the instant shown.



Good Luck

AL-Balqa Applied University
Faculty of Engineering Technology

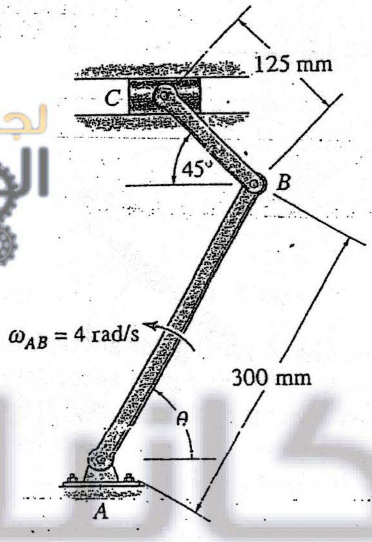
Mechanical department

Final exam – Dynamics

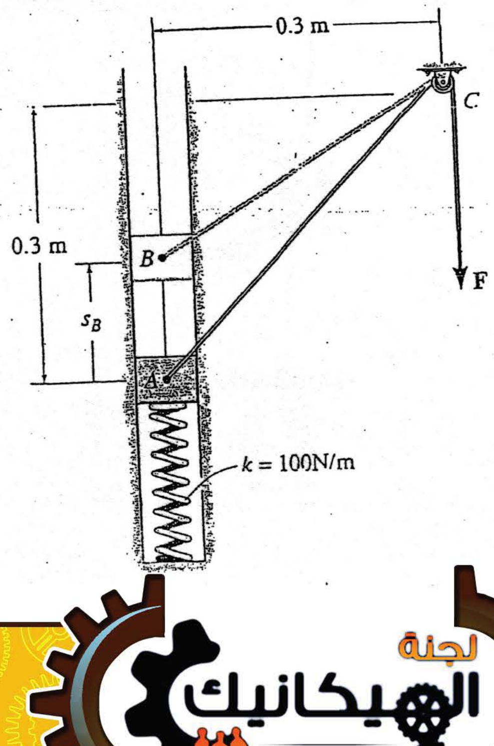
2008-2009

Dr. Salameh Swalha
Dr : Mohamed Gaith

Q1 (12 point) The shaper mechanism is designed to give a slow cutting stroke and a quick return to a blade attached to the slider at C. Determine the velocity of the slider block C at the instant $\theta = 60°$, if link AB is rotating at 4 rad/s.

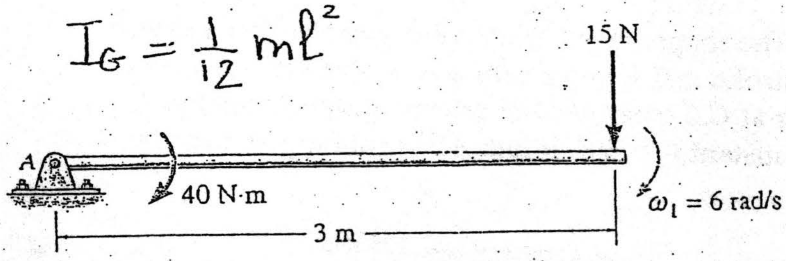


Q2(13 point) The block has a mass of 0.5 kg and moves within the smooth vertical slot. If the block starts from rest when the *attached* spring is in the unstretched position at A, determine the *constant* vertical force F which must be applied to the cord so that the block attains a speed $v_B = 2.5$ m/s when it reaches B; $s_B = 0.15$ m. Neglect the mass of the cord and pulley.

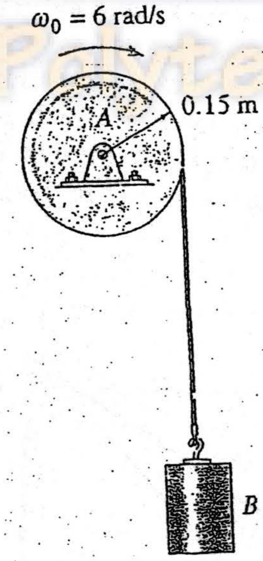


Q3 (13 point) The 4-kg slender rod is subjected to the force and couple moment. When the rod is in the position shown it has a angular velocity $\omega_1 = 6$ rad/s. Determine its angular velocity at the instant it has rotated 360°. The force is always applied perpendicular to the axis of the rod and motion occurs in the vertical plane.

$I_G = \frac{1}{12} m l^2$



Q4(12 point) A motor gives disk A an angular acceleration of $\alpha_A = (0.6t^2 + 0.75)$ rad/s², where t is in seconds. If the initial angular velocity of the disk is $\omega_0 = 6$ rad/s, determine the magnitudes of the velocity and acceleration of block B when $t = 2$ s.



Good Luck