



Answer only five questions

- Q1:** The relation $X = t^2 - 5t + 6$ defines the motion of a particle where, x in meter and t in second, determine:
a- when the particle passes through the origin (0,0)?
b- velocity and acceleration when the particle is return to its original position.
c- the position and the total distance traveled after 6 seconds. **(20 marks)**
- Q2:** The drinking foundation is designed such that the nozzle is located from the edge of the basin as shown in figure (1). Determine the maximum and minimum speed at which water can be ejected from the nozzle so that it does not splash over the sides of the basin at B and C. **(20 marks)**
- Q3:** If the sack at A in figure (2) has a weight of 20 N, determine the weight of the sack at B and the force in each cord needed to hold the system in the equilibrium position shown. **(20 marks)**
- Q4:** Determine the magnitude and direction of the resultant force of the two forces shown in figure (3) **(20 marks)**
- Q5:** What is the range of mass m_o so that the 500Kg mass shown in figure (4) not move upward or downward? **(20 marks)**
- Q6:** Locate the centroid of the shaded area shown in figure (5). Then find the moment of inertia about Y-axis. **(20 marks)**

Good Luck

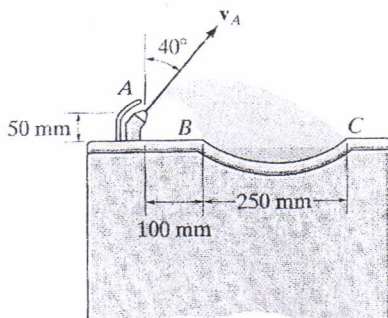


Fig. (1)

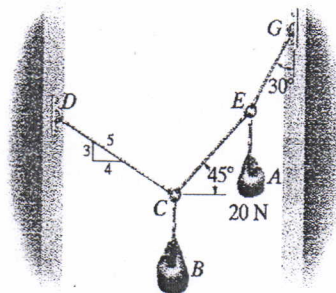


Fig. (2)

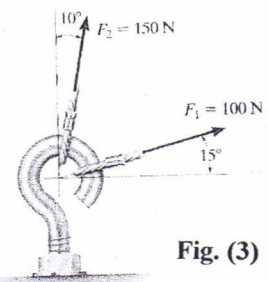


Fig. (3)

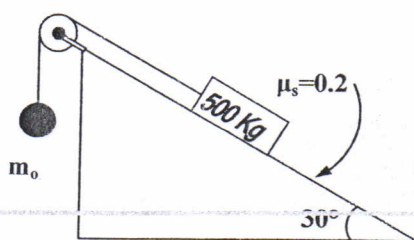
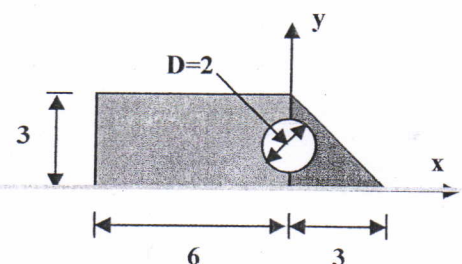


Fig. (4)



All dimensions in mm

Fig. (5)

2-2016

Q1

(a) $x = t^2 - 5t + 6$
 $0 = (t-3)(t-2)$
 $t = 2 \text{ s} \ \& \ t = 3 \text{ s}$

(b) $6 = t^2 - 5t + 6$
 $t^2 - 5t = 0$
 $t(t-5) = 0 \Rightarrow t = 0 \ \& \ t = 5 \text{ sec.}$

$$v = \frac{dx}{dt} = 2t - 5$$

$$v_{t=5} = 2(5) - 5 = 5 \text{ m/s.}$$

$$a = \frac{dv}{dt} = 2 \text{ m/s}^2$$

(c) test motion.

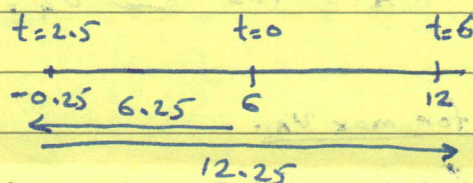
$$v = \frac{dx}{dt} = 2t - 5$$

$$0 = 2t - 5 \Rightarrow t = 2.5 \text{ sec.}$$

$$x_{t=0} = 6 \text{ m}$$

$$x_{t=2.5} = (2.5)^2 - 5(2.5) + 6 = -0.25 \text{ m}$$

$$x_{t=6} = (6)^2 - 5(6) + 6 = 12 \text{ m.}$$



$$D_{0 \rightarrow 6} = |x_{t=0} - x_{t=2.5}| + |x_{t=2.5} - x_{t=6}|$$

$$= |6 - (-0.25)| + |-0.25 - 12|$$

$$= 6.25 + 12.25$$

$$= 18.5 \text{ m.}$$

2-2016

Q2

$$v_{ox} = v_A \sin 40 = 0.6428 v_A$$

$$v_{oy} = v_A \cos 40 = 0.766 v_A$$

for min v_A

$$x = x_0 + v_{ox} t$$

$$0.1 = 0.6428 v_A t$$

$$t = \frac{0.1}{0.6428 v_A} = \frac{0.1555}{v_A}$$

$$y = y_0 + v_{oy} t - \frac{1}{2} g t^2$$

$$0 = 0.05 + 0.766 v_A \left(\frac{0.1555}{v_A} \right) - 5 \left(\frac{0.1555}{v_A} \right)^2$$

$$= 0.05 + 0.1192 - \frac{0.121}{v_A^2}$$

$$v_A^2 = 0.715 \Rightarrow v_A = 0.845 \text{ m/sec} \quad \text{if } g = 9.81 \quad 0.838 \text{ m/sec.}$$

for max v_A

$$x = x_0 + v_{ox} t$$

$$0.35 = 0.6428 v_A t$$

$$t = \frac{0.35}{0.6428 v_A} = \frac{0.5445}{v_A}$$

$$0 = 0.05 + 0.766 v_A \left(\frac{0.5445}{v_A} \right) - 5 \left(\frac{0.5445}{v_A} \right)^2$$

$$= 0.05 + 0.417 - \frac{1.482}{v_A^2}$$

$$v_A^2 = 3.173$$

$$v_A = 1.78 \text{ m/sec}$$

$$\text{if } g = 9.81 \quad 1.76 \text{ m/sec.}$$

2-2016

Q3 Node E

$$\sum F_x = 0$$

$$T_{EG} \sin 30^\circ = T_{EC} \cos 45^\circ$$

$$T_{EG} = 2 T_{EC} \cos 45^\circ$$

$$\sum F_y = 0$$

$$T_{EG} \cos 30^\circ - 20 - T_{EC} \sin 45^\circ = 0$$

$$2 T_{EC} \cos 45^\circ \cos 30^\circ - 20 - T_{EC} \sin 45^\circ = 0$$

$$1.2247 T_{EC} - 20 - 0.7071 T_{EC} = 0$$

$$0.5176 T_{EC} = 20$$

$$T_{EC} = 38.64 \text{ N}$$

$$T_{EG} = 2 (38.64) \cos 45^\circ = 54.64 \text{ N}$$

Node C

$$\sum F_x = 0$$

$$T_{EC} \cos 45^\circ - T_{CD} \left(\frac{4}{5}\right) = 0$$

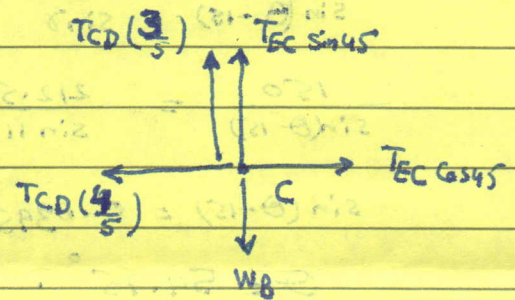
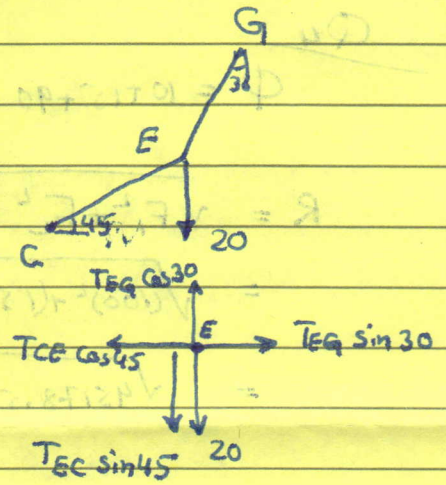
$$T_{CD} = 38.64 \times 0.707 \times \frac{5}{4} = 34.15 \text{ N}$$

$$\sum F_y = 0$$

$$T_{EC} \sin 45^\circ + T_{CD} \left(\frac{3}{5}\right) - W_B = 0$$

$$W_B = 38.64 (0.707) + 0.6 (34.15)$$

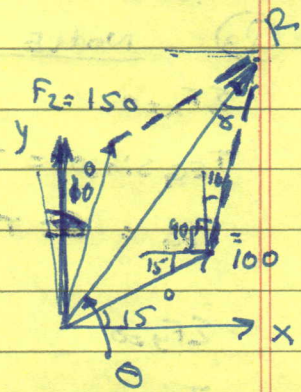
$$= 47.81 \text{ N}$$



Q4

$$\Phi = 10 + 15 + 90 = 115^\circ$$

$$\begin{aligned} R &= \sqrt{F_1^2 + F_2^2 - 2F_1F_2 \cos \Phi} \\ &= \sqrt{(100)^2 + (150)^2 - 2(100)(150) \cos 115} \\ &= \sqrt{45178.5} = 212.55 \text{ N} \end{aligned}$$



$$\tan^{-1} \theta = \frac{R_y}{R_x} = \text{(If use analytical method)}$$

$$\frac{F_2}{\sin(\theta - 15)} = \frac{F_1}{\sin \theta} = \frac{R}{\sin 115}$$

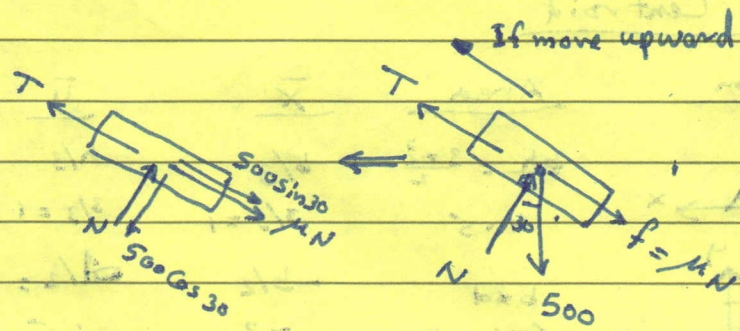
$$\frac{150}{\sin(\theta - 15)} = \frac{212.55}{\sin 115}$$

$$\sin(\theta - 15) = 0.6395$$

$$\theta = 54.75^\circ$$

2-2016

Q5



$$\sum F_y = 0$$

$$N = 500 \cos 30 = 250\sqrt{3}$$

$$\sum F_x = 0$$

$$T = 500 \sin 30 + \mu N$$

$$= 250 + 0.2 \times 250\sqrt{3}$$

$$= 336.6 \text{ Kg}$$

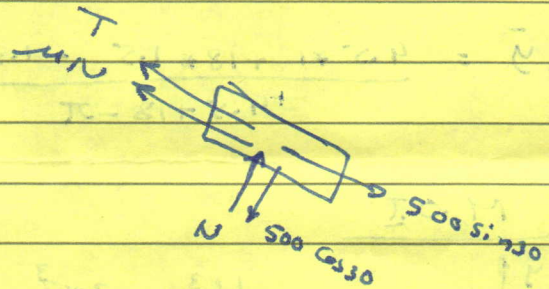
If move downward.

$$\sum F_x = 0$$

$$T = 500 \sin 30 + \mu N$$

$$= 250 - 0.2 \times 250\sqrt{3}$$

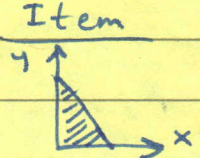
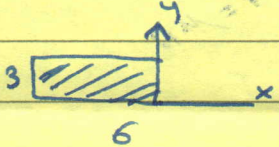
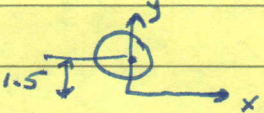
$$= 163.4 \text{ Kg}$$



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Q6


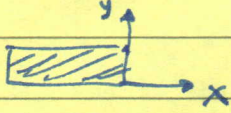
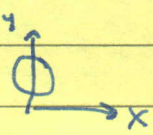
Centroid

Item	Area	\bar{X}	\bar{y}
	$\frac{bh}{2} = \frac{3 \times 3}{2} = 4.5$	$\frac{b}{3} = \frac{3}{3} = 1$	$\frac{h}{3} = \frac{3}{3} = 1$
	$b \times d = 6 \times 3 = 18$	$-\frac{b}{2} = -3$	$\frac{d}{2} = \frac{3}{2} = 1.5$
	$-\pi r^2 = -\pi \times 1$ $-\pi$	0	1.5

$$\bar{X} = \frac{4.5 \times 1 + 18 \times (-3) - \pi \times 0}{4.5 + 18 - \pi} = -2.557 \text{ mm}$$

$$\bar{y} = \frac{4.5 \times 1 + 18 \times 1.5 - 1.5\pi}{4.5 + 18 - \pi} = 1.38 \text{ mm}$$

M.O.I

	$\frac{bh^3}{12} = \frac{3 \times 3^3}{12} = 6.75 \text{ mm}^4$
	$\frac{bh^3}{3} = \frac{3 \times 6^3}{3} = 216 \text{ mm}^4$
	$\frac{-\pi r^4}{4} = \frac{-\pi \times 1}{4} = -0.785 \text{ mm}^4$

$$M.O.I = 6.75 + 216 - 0.785 = \underline{\underline{221.96 \text{ mm}^4}}$$