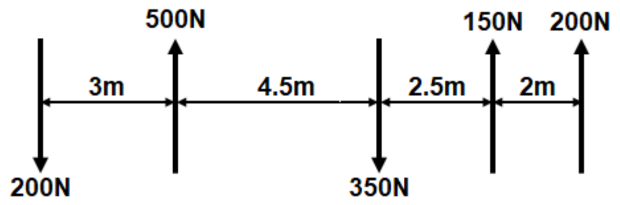
1. **Attempt All Questions.**

a) **Determine the resultant of the following system of parallel forces.**



Solution:

Magnitude of Resultant

$R = \sum F = 500 + 150 + 200 - 200 - 350$

$R = 300N$

Moment of Forces

$\sum M = 500 \times 3 - 350 \times 7.5 + 150 \times 10 + 200 \times 12$

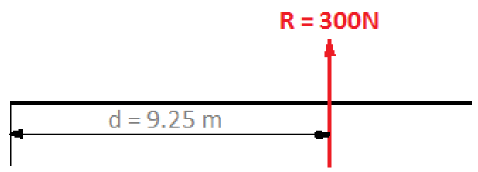
$\sum M = 2775$ Nm

Position of Resultant can be calculated by Applying Varignon's Theorem

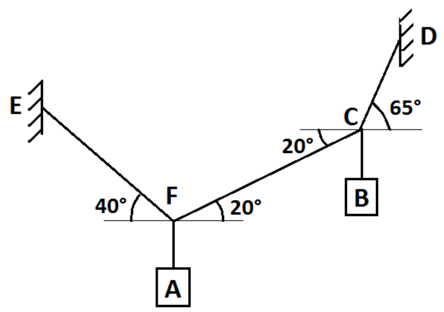
$d = \frac{\sum M}{R}$

$d = \frac{2775}{300}$

d = 9.25 m



b) **If the cords suspend the two buckets in the equilibrium position shown in Fig. Determine the weight of bucket B. Bucket A has a weight of 60 N.**



Solution:

Consider FBD of point F:

By Lami's Theorem,

$$\frac{T_{EF}}{\sin 110} = \frac{T_{FC}}{\sin 130} = \frac{60}{\sin 120}$$

$T_{FC} = 53.07N$

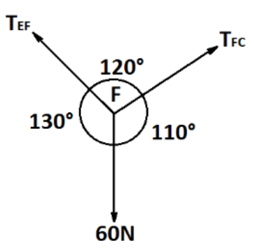
Consider FBD of point C:

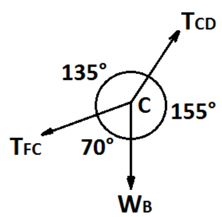
By Lami's Theorem,

$$\frac{T_{FC}}{\sin 155} = \frac{W_B}{\sin 135}$$

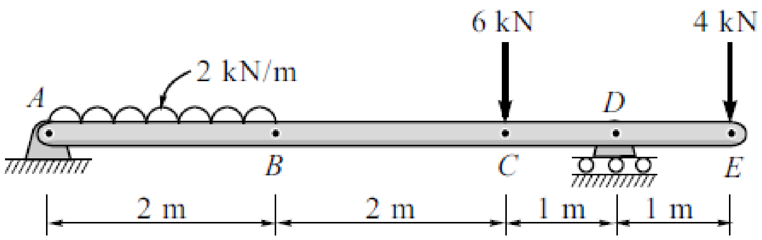
$$\frac{53.07}{\sin 155} = \frac{W_B}{\sin 135}$$

$W_B = 89.85N$





c) **Determine the reactions at all the supports of the beam shown in Fig.**



Solution:

By condition of equilibrium

$\sum F_x = 0$, $\quad$ $\boldsymbol{H_A = 0}$

$\sum M_A = 0$

$-4 \text{ x } 1 - 6 \text{ x } 4 - 4 \text{ x } 6 + R_D \text{ x } 5 = 0$

$\boldsymbol{R_D = 10.4 \text{ kN}}$

$\sum F_y = 0$

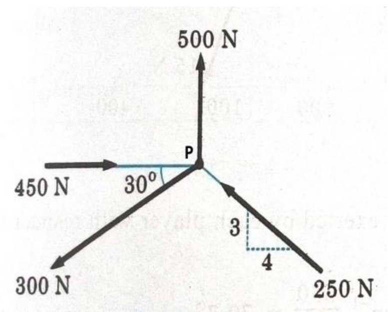
$V_A - 4 - 6 - 4 + R_D = 0$

$V_A - 4 - 6 - 4 + 10.4 = 0$

$\boldsymbol{V_A = 3.6 \text{ kN}}$

2. **Attempt All Questions.**

a) **Find the resultant of the force acting on a particle P shown in Fig.**



Solution:

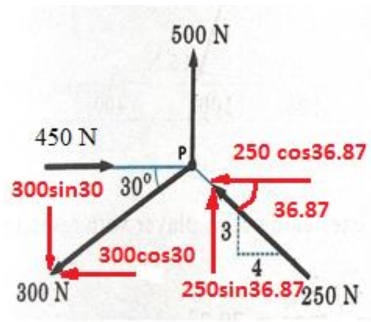
$Rx = \sum Fx = 450 - 250 \cos 36.87 - 300 \cos 30$

$= -9.81$ N

Rx = 9.81 N (←)

$Ry = \sum Fy = 500 + 250 \sin 36.87 - 300 \sin 30$

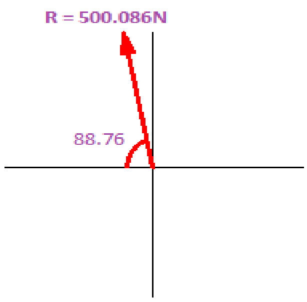
Ry = 500 N(↑)



Magnitude of Resultant:

$R = \sqrt{R_x^2 + R_y^2}$ $\quad R = \sqrt{9.81^2 + 500^2}$

R = 500.096 N



Direction:

$\Theta = \tan^{-1}\frac{Ry}{Rx} = \tan^{-1}\frac{500}{9.81} = 88.76$

ϴ = 88.76

b) The equation of motion of a particle moving in a straight line is given by

$$\mathbf{s = 18t + 3t^{2} - 2t^{3}}$$

where's' is in meters &'t' in seconds. Find (1) the velocity and acceleration at start (2) The time when the particle reaches its maximum velocity and (3) The maximum velocity of the particle.

Solution:

$s = 18t + 3t^{2} - 2t^{3}$ .... (i)

Differentiate w.r.t. 't'

$v = \frac{ds}{dt} = 18 + 6t - 6t^{2}$ .... (ii)

Differentiate w.r.t. 't'

$a = \frac{dv}{dt} = 6 - 12t$ .... (iii)

i. Velocity and acceleration at start:

Sub. t = 0 in eqn (ii) & (iii)

$v = 18 + 6(0) - 6(0)^{2}$

v = 18 m/s

a = 6 – 12 (0)

a = 6 m/ s^2

ii. The time when the particle reaches its maximum velocity:

For max. or min. velocity,

$a = \frac{dv}{dt} = 0$

From equation (iii)

0 = 6 – 12t

t = 0.5 sec

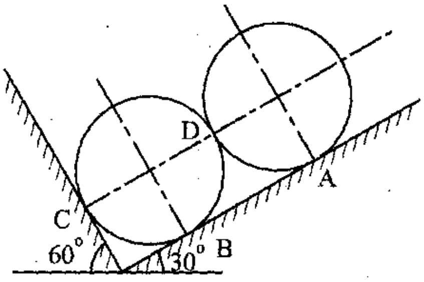
iii. The maximum velocity of the particle:

Sub. t = 0.5 in equation (ii)

$v_{max} = 18 + 6(0.5) - 6(0.5)^{2}$

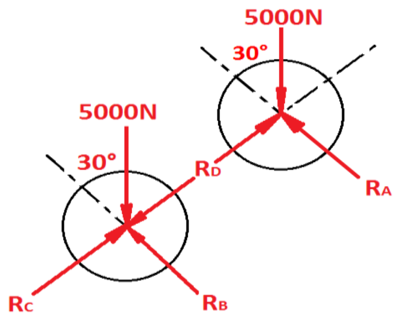
v_{max} = 19.5 m/s

c) **Two homogeneous solid cylinders of each having weight 5000N and radius 0.4m are resting as shown in Fig. Assume all smooth surfaces find the reactions at A, B, C, D of the contact points on ground and wall.**



Solution:

F.B.D. of upper cylinder:



F.B.D.

By Lami's Theorem,

$$\frac{R_D}{\sin 150} = \frac{R_A}{\sin 120} = \frac{5000}{\sin 90}$$

$\boldsymbol{R_D}$ **= 2500 N**

$\boldsymbol{R_A}$ **= 4330.13 N**

F.B.D. of lower cylinder:

By condition of equilibrium,

Considering centre line as x-axis,

$\sum F_x = 0$

R_c - R_D- 5000sin30 = 0

R_c - 2500 - 5000sin30 = 0

$\boldsymbol{R_c}$ **= 5000N**

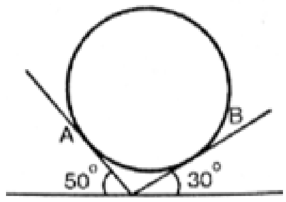
$\sum F_y = 0$

R_B - 5000cos30 = 0

$\boldsymbol{R_B}$ **= 4330.13N**

3. Attempt All Questions.

a) **A cylinder of weight 500N is kept on two inclined planes as shown in fig. Determine the reactions at contact points A and B.**

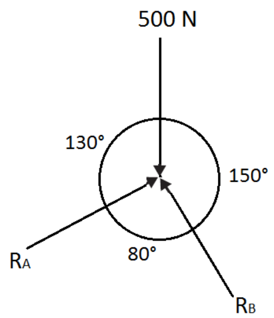


Solution:

Since there are three concurrent forces & system is in equilibrium.

Applying Lami's Theorem,

$$\frac{R_A}{\sin 150} = \frac{R_B}{\sin 130} = \frac{500}{\sin 80}$$



$\boldsymbol{R_A}$ **= 253.86N**

$\boldsymbol{R_B}$ **= 388.93 N**

b) The acceleration of a particle which moves with rectilinear translation is given by a = (t − 2) m/s^2, at t = 0, the displacement and velocity are zero. Find the velocity and displacement when t = 2 sec. And when t= 4 sec.

Solution:

a = t – 2 ……………. (i)

$\frac{dv}{dt}$ = t – 2

dv = (t – 2) dt

Integrating on both sides

$\int dv = \int (t - 2)\,dt$

$v = \frac{t^2}{2} - 2t + c_1$

At t= 0, v = 0, hence $c_1 = 0$

$v = \frac{t^2}{2} - 2t$ …………… (ii)

$\frac{ds}{dt} = \frac{t^2}{2} - 2t$

$ds = \left(\frac{t^2}{2} - 2t\right)dt$

Integrating on both side

$\int ds = \left(\frac{t^2}{2} - 2t\right)dt$

$s = \frac{t^3}{6} - t^2 + c_2$

At t= 0, s = 0, hence $c_2 = 0$

$s = \frac{t^3}{6} - t^2$ ………….. (iii)

i. **The displacement and velocity at t = 2 sec**

Sub t=2 in equation (ii) & (iii)

$v = \frac{(2)^2}{2} - 2(2)$

v = – 2 m/s

$s = \frac{(2)^3}{6} - (2)^2$

s = – 2.67m

ii. **The displacement and velocity at t = 4 sec**

Sub t=4 in equation (ii) & (iii)

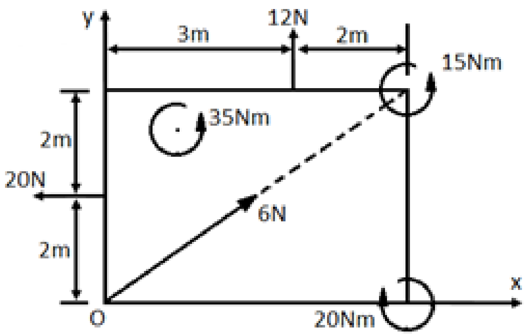
$v = \frac{(4)^2}{2} - 2(4)$

v = 0 m/s

$s = \frac{(4)^3}{6} - (4)^2$

s = – 5.33m

c) Replace the given system of forces and couples by a single force and locate it on the x axis through which the line of action of the resultant.



Solution:

$\tan \theta = \frac{4}{5}$

$\theta = 38.66°$

$R_x = \sum F_x = 6\cos 38.66 - 20 = -15.31$

$\boldsymbol{R_x}$ **= 15.31 N (←)**

$R_y = \sum F_y = 12 + 6\sin 38.66 = 15.75$

$\boldsymbol{R_y}$**= 15.75 N (↑)**

Magnitude of Resultant is

$R = \sqrt{R_x^2 + R_y^2} = \sqrt{15.31^2 + 15.75^2}$

R = 21.96 N

Direction of Resultant is

$\tan\theta = \frac{R_y}{R_x} = \frac{15.75}{15.31}$

$\boldsymbol{\theta}$ **= 45.81°**

$\sum M_o = 35 + 15 + 20 \times 2 + 12 \times 3 - 20$

$\boldsymbol{\sum M_o}$ **= 106 N.m (↺)**

Position of Resultant:

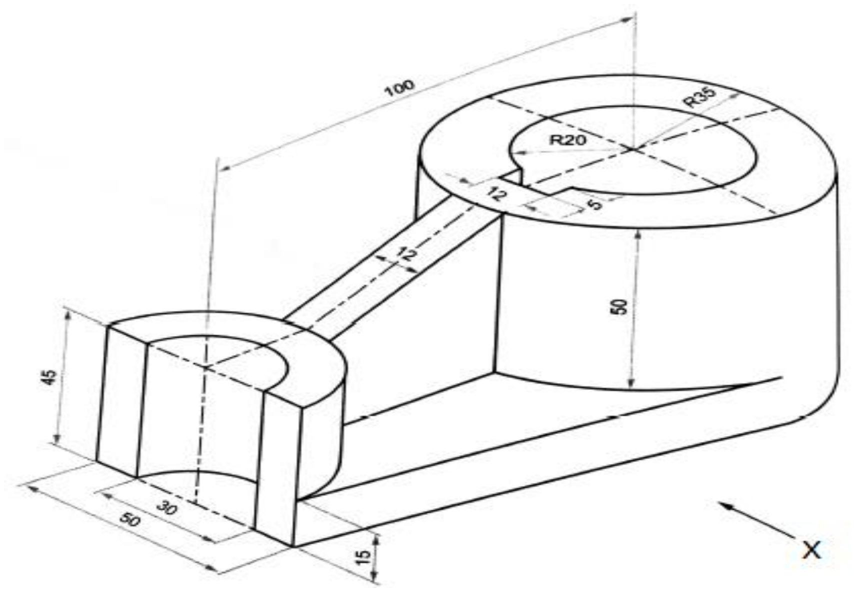
By Varignon's Theorem

$x = \frac{\sum M}{R_y} = \frac{106}{15.75}$

x = 6.73m

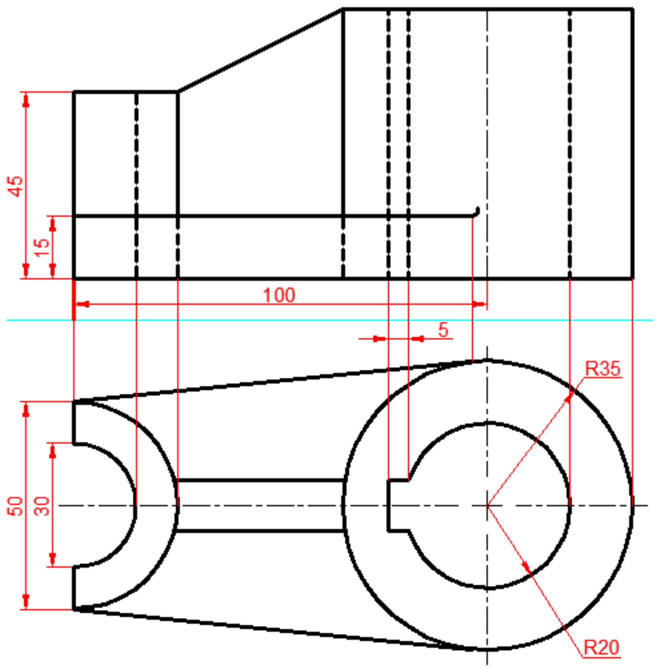
Section B: Engineering Graphics

1. **Attempt All Questions.**
   a) Using the first angle method of projection draw the following views-
   - **a)** Front view in the direction of arrow X
   - **b)** Top View



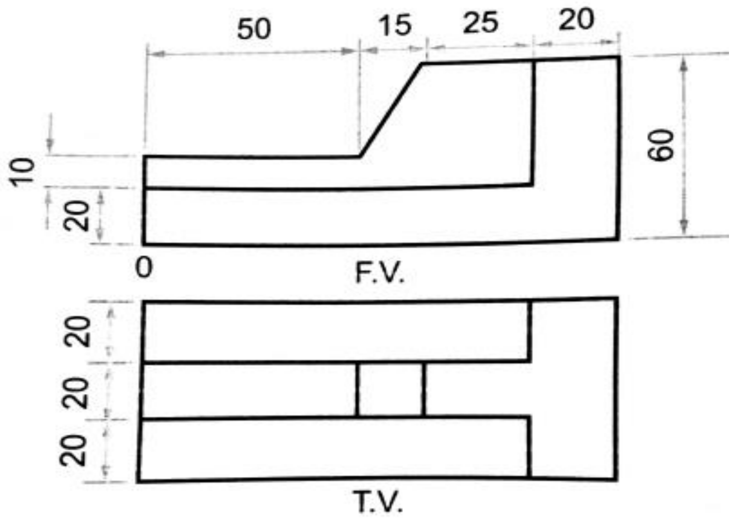
Solution:

F.V.

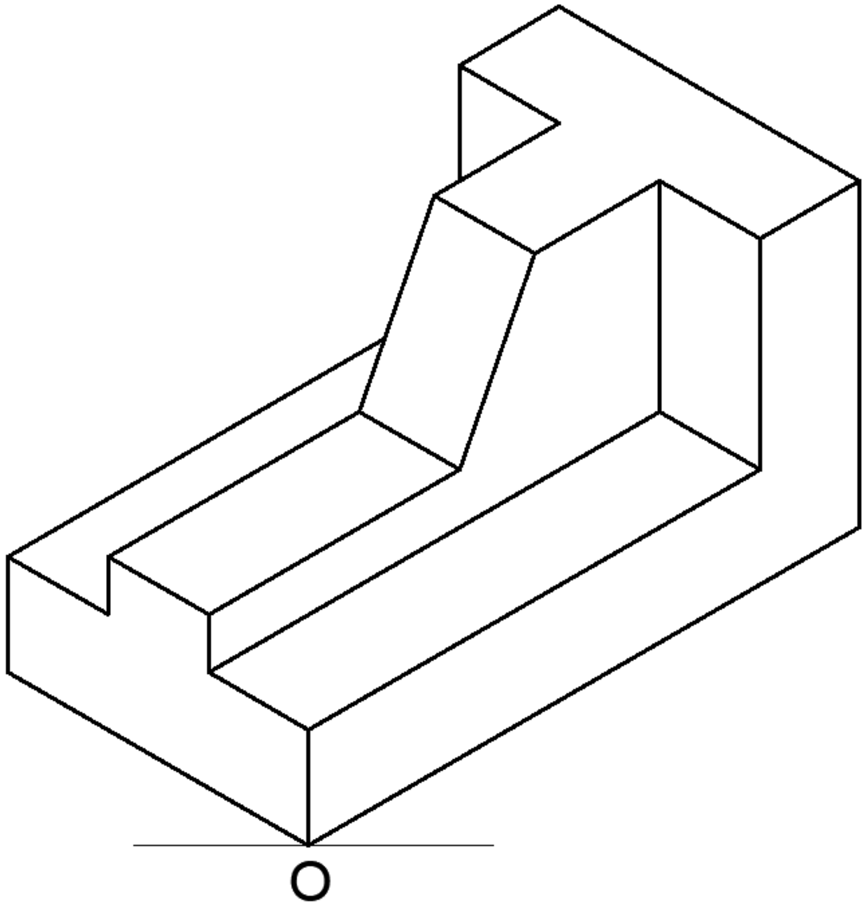


T.V.

b) Draw isometric projections using natural scale.

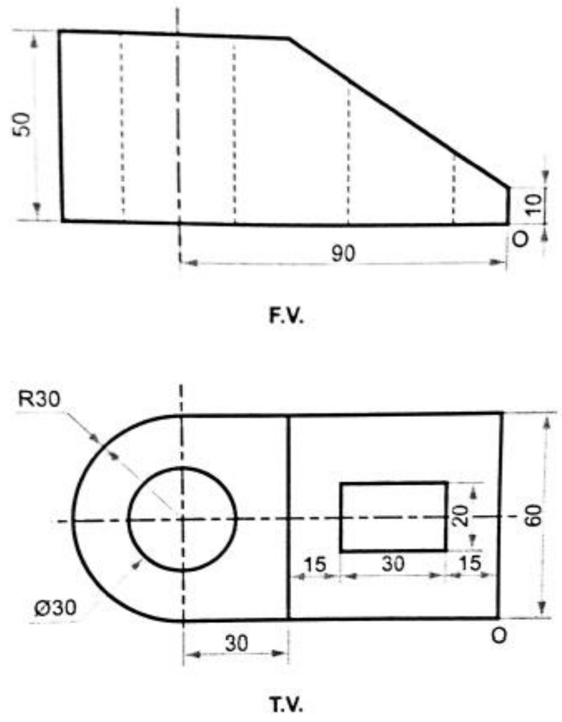


Solution:

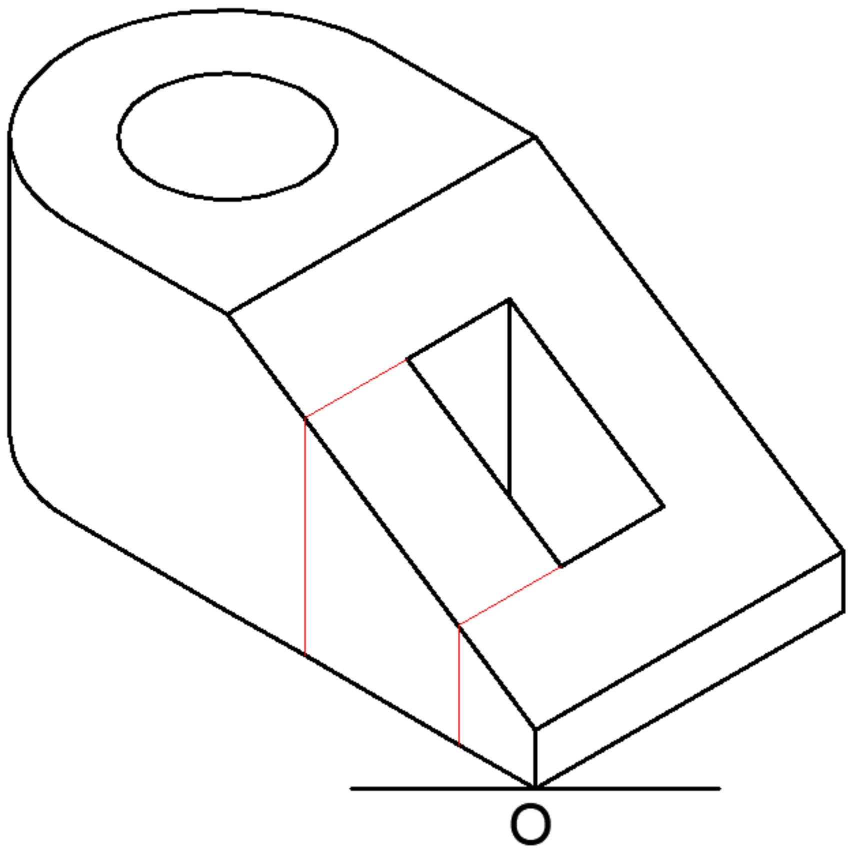


2. **Attempt All Questions.**

   a) Draw isometric projections using natural scale.

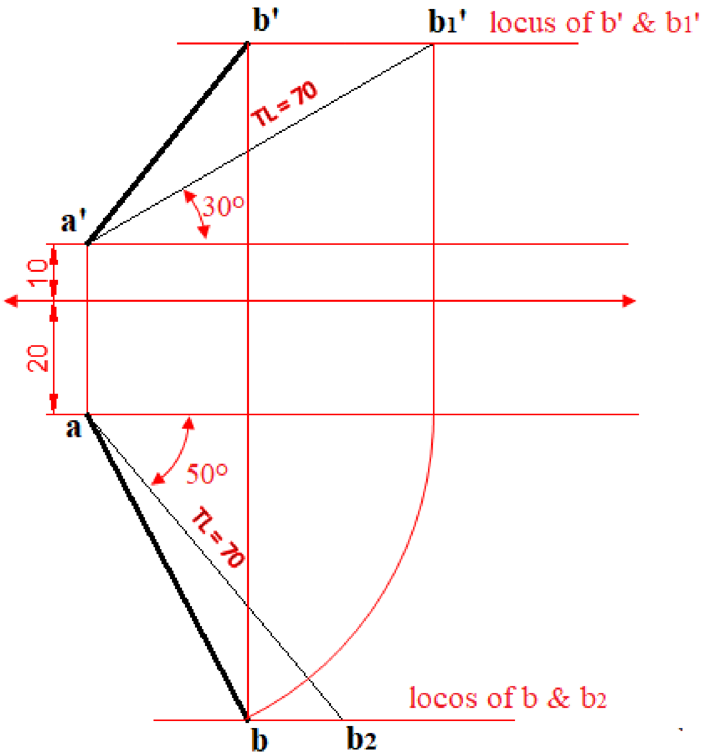


Solution:

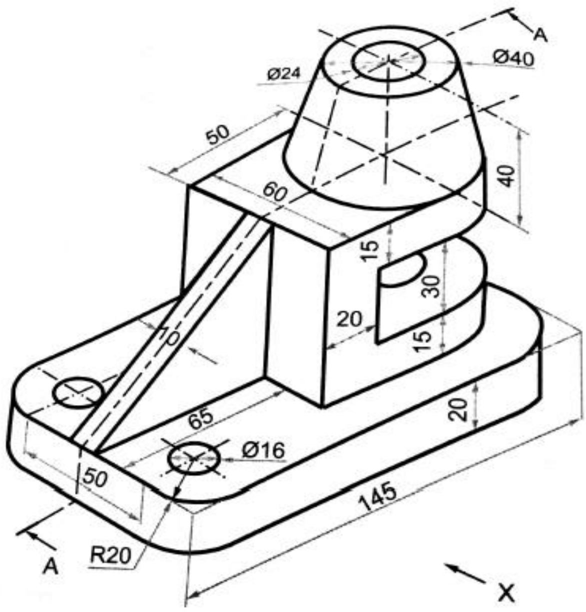


b) **Line AB 70mm long is inclined at 30° to HP and 50° to VP. Its end A is 10mm above HP and 20mm in front of VP, while its end B is in 1st quadrant. Draw projections of line AB.**

Solution:



3. **Draw : a) Sectional F.V. (along A-A) b) T.V .c) L.H. S.V.**



Solution: