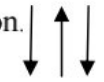
Parallel forces on a plane

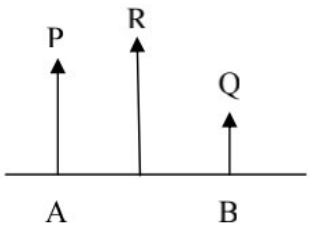
Like parallel forces: Coplanar parallel forces when act in the same direction.

Unlike parallel forces: Coplanar parallel forces when act in different direction.



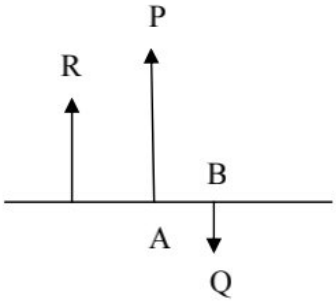
Resultant of like parallel forces:

Let P and Q are two like parallel forces act at points A and B.
R = P + Q



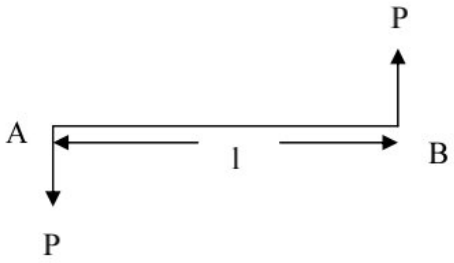
Resultant of unlike parallel forces:
R = P - Q

R is in the direction of the force having greater magnitude.



Couple:

Two unlike equal parallel forces form a couple.

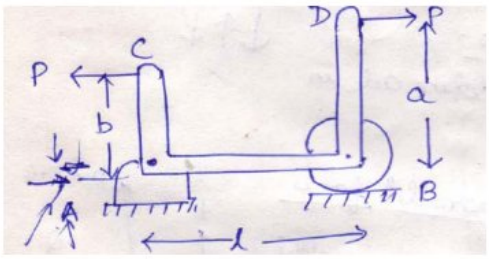


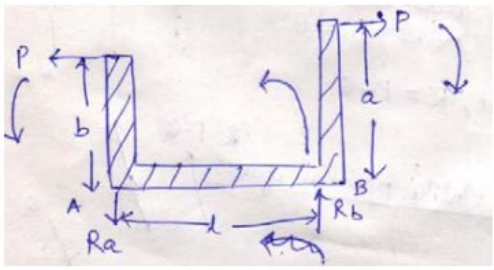
The rotational effect of a couple is measured by its moment.

Moment = P × l

Sign convention: Anticlockwise couple (Positive)
Clockwise couple (Negative)

Problem 1 : A rigid bar CABD supported as shown in figure is acted upon by two equal horizontal forces P applied at C and D. Calculate the reactions that will be induced at the points of support. Assume l = 1.2 m, a = 0.9 m, b =0.6 m.





$$\sum V = 0$$

$$R_a = R_b$$

Taking moment about A,

$$R_a = R_b$$

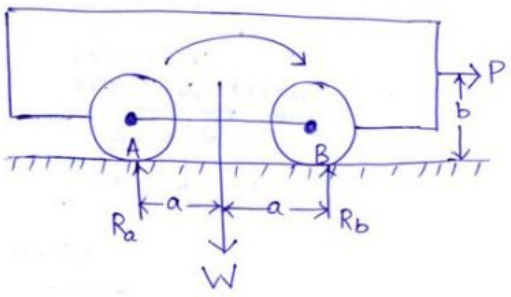
$$R_b \times l + P \times b = P \times a$$

$$\Rightarrow R_b = \frac{P(0.9 - 0.6)}{1.2}$$

$$\Rightarrow R_b = 0.25P(\uparrow)$$

$$\Rightarrow R_a = 0.25P(\downarrow)$$

Problem 2: Owing to weight W of the locomotive shown in figure, the reactions at the two points of support A and B will each be equal to W/2. When the locomotive is pulling the train and the drawbar pull P is just equal to the total friction at the points of contact A and B, determine the magnitudes of the vertical reactions R_a and R_b.



$$\sum V = 0$$

$$R_a + R_b = W$$

Taking moment about B,

$$\sum M_B = 0$$

$$R_a \times 2a + P \times b = W \times a$$

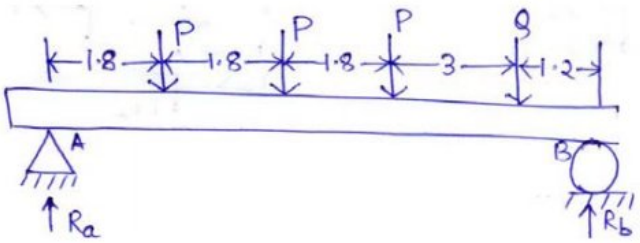
$$\Rightarrow R_a = \frac{W.a - P.b}{2a}$$

$$\therefore R_b = W - R_a$$

$$\Rightarrow R_b = W - \left(\frac{W.a - P.b}{2a}\right)$$

$$\Rightarrow R_b = \frac{W.a + P.b}{2a}$$

Problem 3: The four wheels of a locomotive produce vertical forces on the horizontal girder AB. Determine the reactions R_a and R_b at the supports if the loads P = 90 KN each and Q = 72 KN (All dimensions are in m).



$$\sum V = 0$$

$$R_a + R_b = 3P + Q$$

$$\Rightarrow R_a + R_b = 3 \times 90 + 72$$

$$\Rightarrow R_a + R_b = 342KN$$

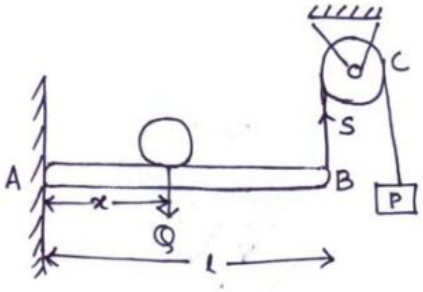
$$\sum M_A = 0$$

$$R_b \times 9.6 = 90 \times 1.8 + 90 \times 3.6 + 90 \times 5.4 + 72 \times 8.4$$

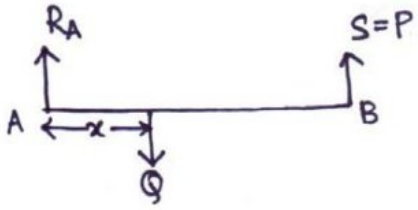
$$\Rightarrow R_b = 164.25KN$$

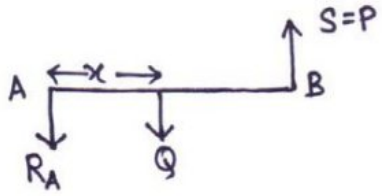
$$\therefore R_a = 177.75KN$$

Problem 4: The beam AB in figure is hinged at A and supported at B by a vertical cord which passes over a frictionless pulley at C and carries at its end a load P. Determine the distance x from A at which a load Q must be placed on the beam if it is to remain in equilibrium in a horizontal position. Neglect the weight of the beam.



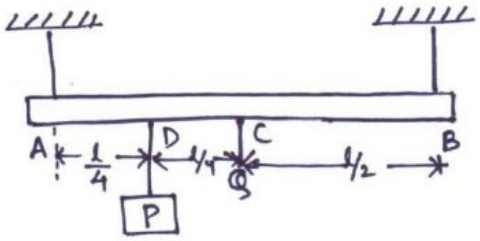
FBD



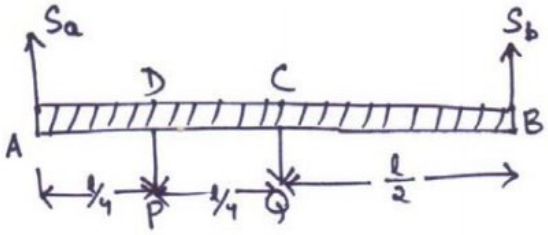


$$\sum M_A = 0$$
$$S \times l = Q \times x$$
$$\Rightarrow x = \frac{P.l}{Q}$$

Problem 5: A prismatic bar AB of weight Q = 44.5 N is supported by two vertical wires at its ends and carries at D a load P = 89 N as shown in figure. Determine the forces S_a and S_b in the two wires.



Q = 44.5 N
P = 89 N



Resolving vertically,
$$\sum V = 0$$
$$S_a + S_b = P + Q$$
$$\Rightarrow S_a + S_b = 89 + 44.5$$
$$\Rightarrow S_a + S_b = 133.5N$$