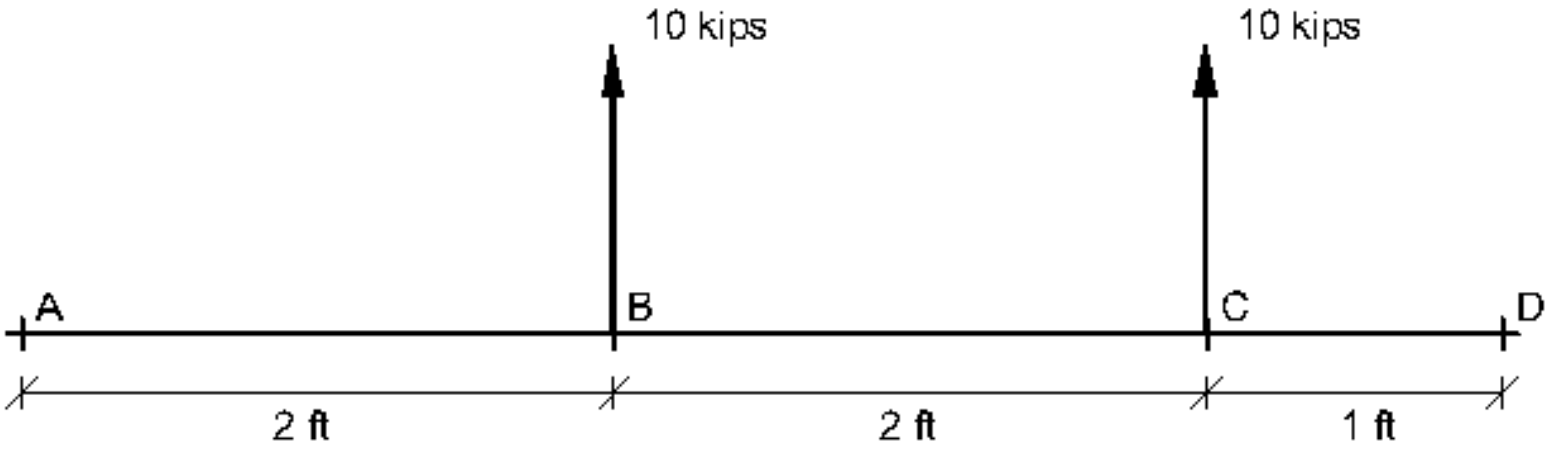
ENSC 2113
Engineering Mechanics: Statics

Lecture 12
Sections 4.7 – 4.8

College of Engineering, Architecture & Technology

4.7: Equivalent System

Replacing a series of forces with a single force:
equivalent force

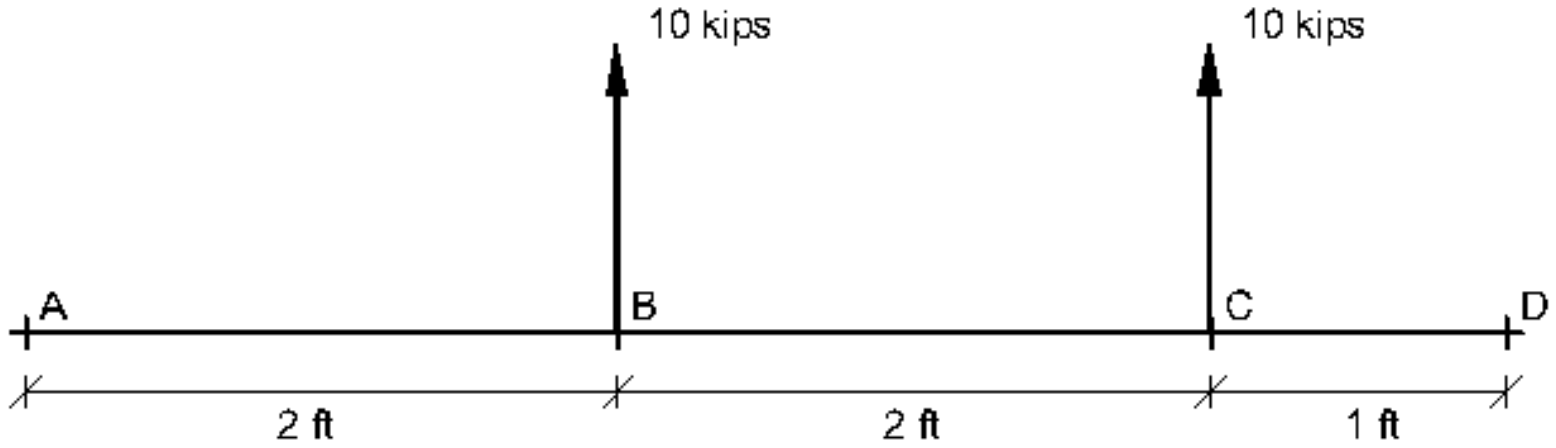


Find the magnitude and location of the equivalent force:

Resultant Force:

$$+\uparrow \sum F_y = 10 + 10 = 20\ kips\ \uparrow$$

let's look at the moments at points **A**, **B**, **C** and **D**:



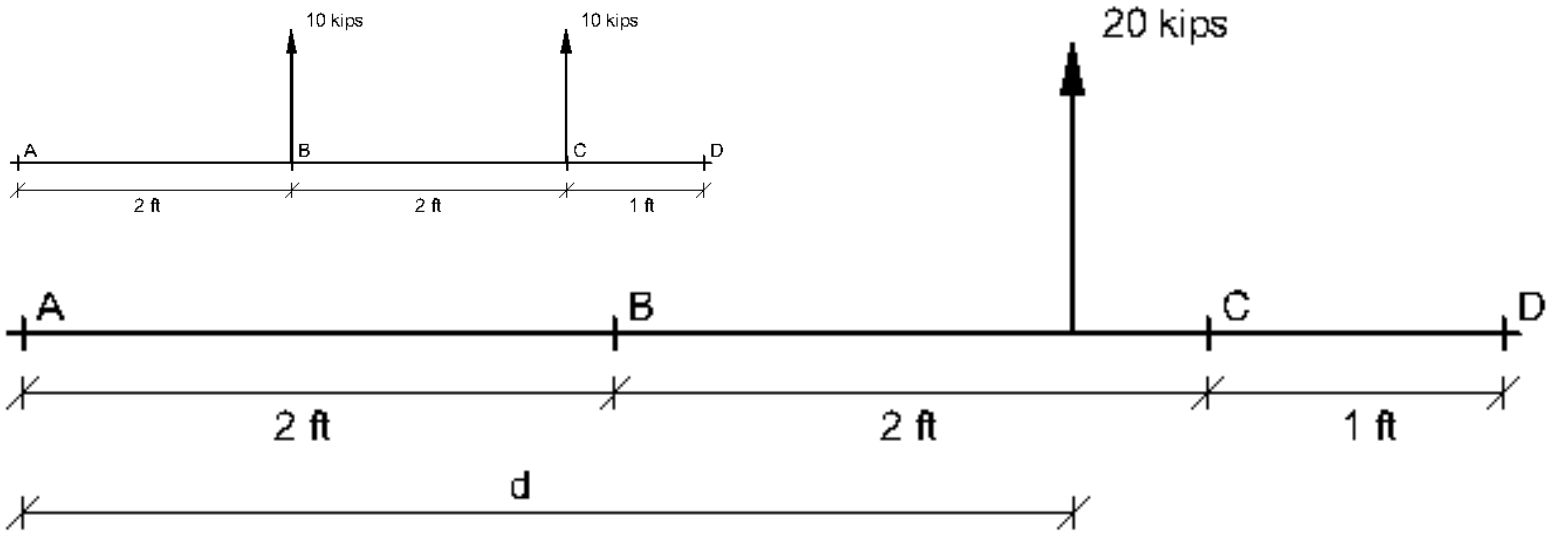
$$+ccw \sum M_A = 10(2) + 10(4) = 60\ kip - ft\ (ccw)$$

$$+ccw \sum M_B = 10(2) = 20\ kip - ft\ (ccw)$$

$$+ccw \sum M_C = -10(2) = -20 = 20\ kip - ft\ (cw)$$

$$+ccw \sum M_D = -10(3) - 10(1) = -40 = 40\ kip - ft\ (ccw)$$

So, we replace the two 10 k forces with a single 20 k force.



Locating the equivalent force from the moment:

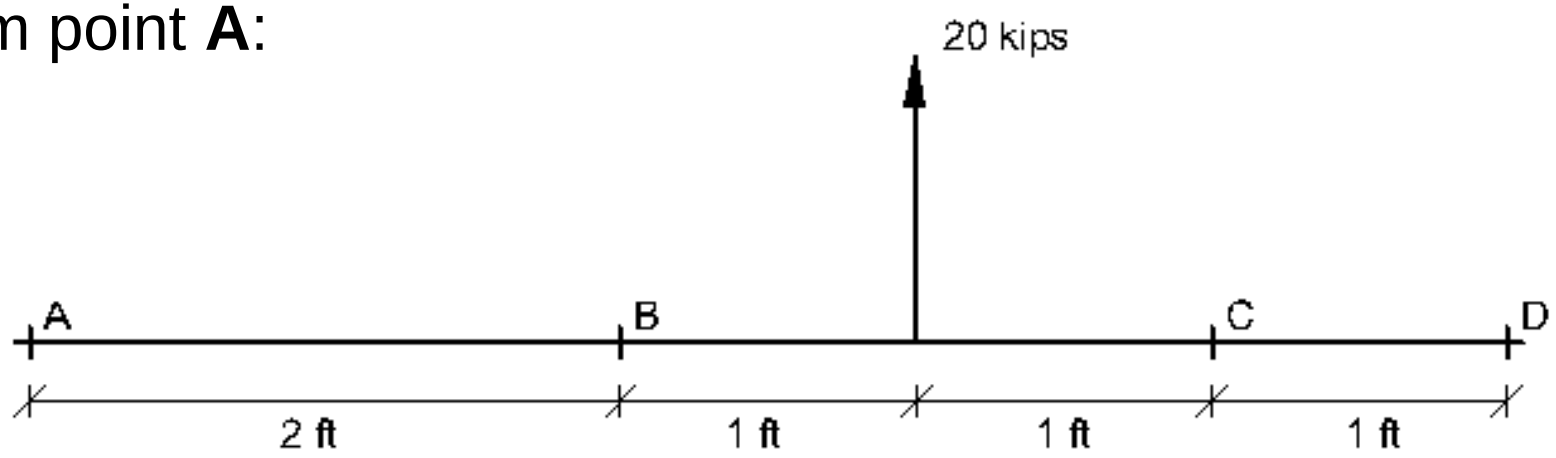
Measured from A:

$$M_A = 60\,k - ft \circlearrowleft$$

Solving for location: $M = F\,d$:

$$60 \circlearrowleft = 20d \qquad d = \frac{60}{20} = 3\,ft$$

The equivalent force is 20 kips at a distance of 3 ft measured from point **A**:



Verify this answer by summing moments at points **B**, **C** & **D**:

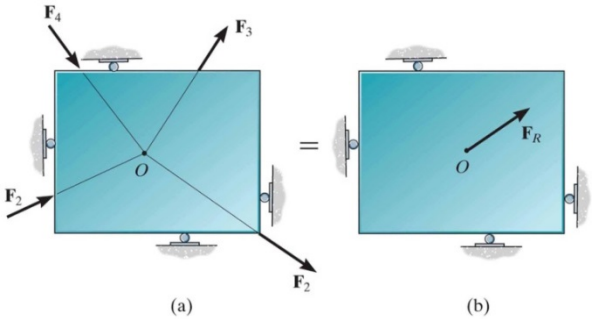
$$+ccw \sum M_B = 20(1) = 20\ kip - ft\ (ccw)$$

$$+ccw \sum M_C = -20(1) = -20 = 20\ kip - ft\ (cw)$$

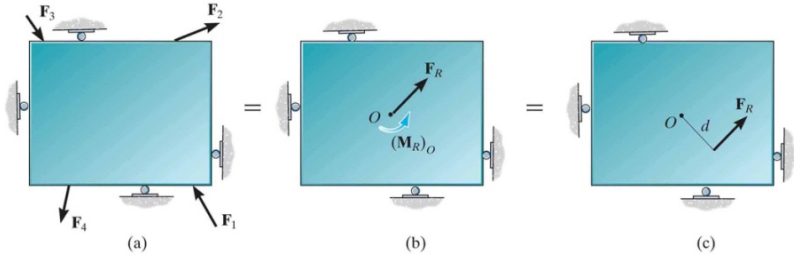
$$+ccw \sum M_D = -20(2) = -40 = 40\ kip - ft\ (ccw)$$

4.8: Resultants of a Force and Couple System

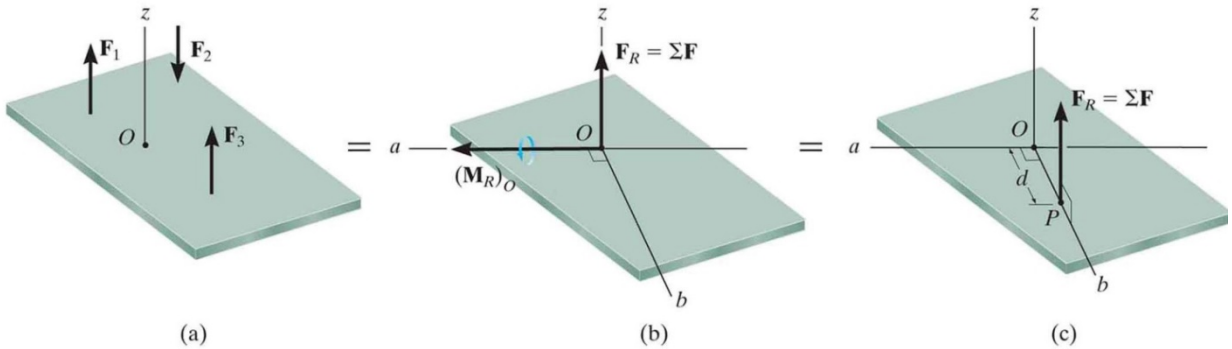
Concurrent force system:



Coplanar force system:



Parallel force system:



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