

University of Leeds
SCHOOL OF CIVIL ENGINEERING

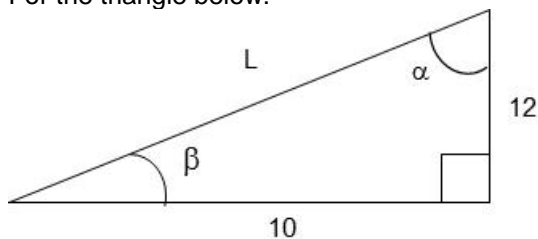
CIVE 1360 Structural Design and Analysis

Tutorial 0 – Background Mechanics

The following questions are aimed at helping you revise your background knowledge in statics. Please try to see if you can progress with all these questions but if you are stuck, please bring your worksheet to Tuesday tutorial sessions and consult one of the tutors present to get the method of solution.

A) Warm up questions

Q1. For the triangle below:

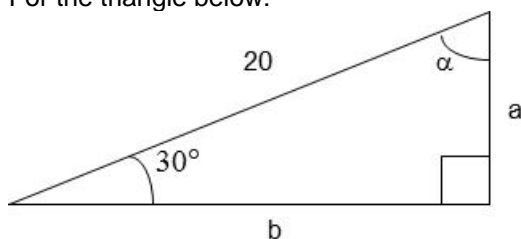


- (a) Calculate the length of hypotenuse L.
- (b) Calculate β
- (c) Calculate α

A1:

- (a) $L = 15.6$
- (b) $\beta = 50.3^\circ$
- (c) $\alpha = 39.7^\circ$

Q2. For the triangle below:

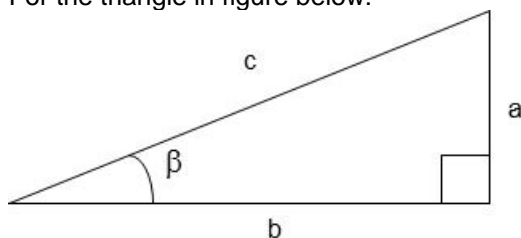


- (a) Compute a
- (b) Compute b
- (c) Write down $\tan 30^\circ$ as a fraction.

A2:

- (a) $a = 10$
- (b) $b = 17.3$
- (c) $\tan 30 = 10/17.3$

Q3. For the triangle in figure below:



- (a) Write down an expression for $\sin \beta$
- (b) Write down an expression for $\cos \beta$
- (c) Write down an expression for $\tan \beta$
- (d) Write down an expression for Pythagoras theorem.

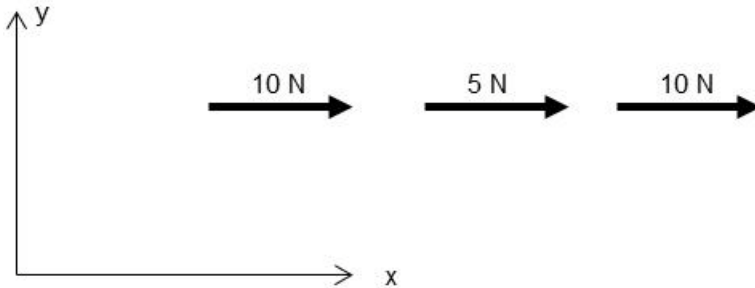
A3:

- (a) $\sin \beta = a/c$
- (b) $\cos \beta = b/c$
- (c) $\tan \beta = a/b$
- (d) $c^2 = a^2 + b^2$

B) Resolution of forces and vectors

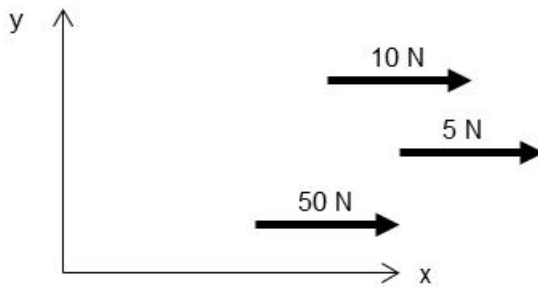
In the following questions all refer to forces in the xy plane.

Q4. Calculate the resultant force in the x-direction for the force system shown in the figure below.



A4:
R = 25 N

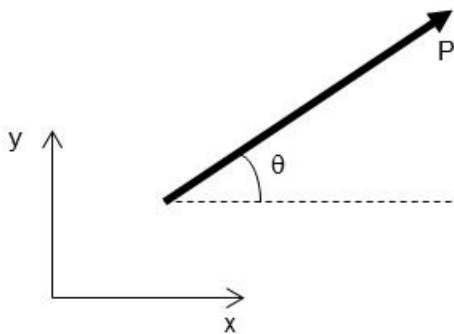
Q5. For the force system shown below,



- (a) Calculate the resultant force in the x-direction.
- (b) Calculate the resultant force in the y-direction.

A5:
(a) $R_x = 65 \text{ N}$
(b) $R_y = 0 \text{ N}$

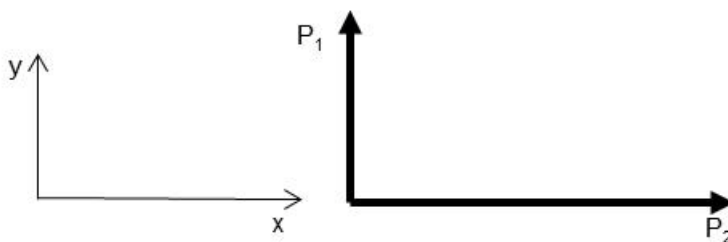
Q6. A force P acts through a point in the xy plane at an angle θ to the positive x axis.



- (a) Calculate the component of P in x.
- (b) Calculate the component of P in y.

A6:
(a) $P_x = P \cos \theta$
(b) $P_y = P \sin \theta$

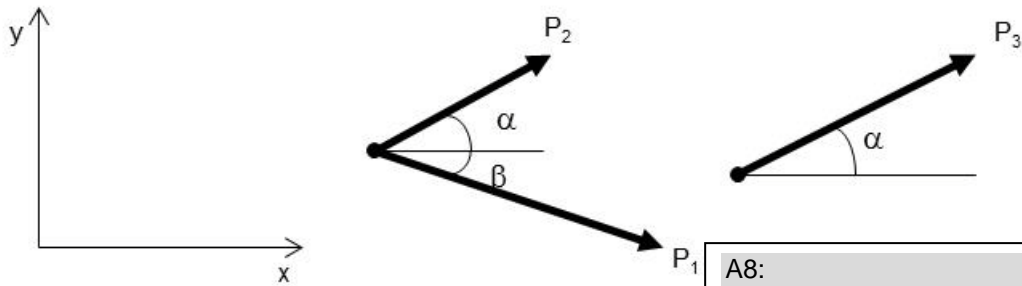
Q7. Two forces P_1 and P_2 acting in the xy plane are shown below.



- (a) Sketch the resultant.
- (b) Write down an expression for magnitude of the resultant.
- (c) At what angle to the x axis does the resultant act.

A7:
(b) $R = \sqrt{P_1^2 + P_2^2}$
(c) $\alpha = \tan^{-1}(P_1/P_2)$

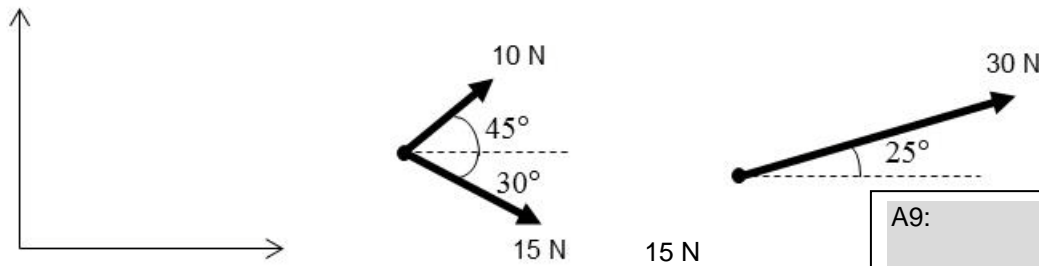
Q8. Three forces in the xy plane act as shown below.



- (a) Compute the resultant in x.
- (b) Compute the resultant in y.

A8:
 (a) $R_x = P_1 \cos \beta + P_2 \cos \alpha + P_3 \cos \alpha$
 (b) $R_y = P_1 \sin \beta + P_2 \sin \alpha + P_3 \sin \alpha$

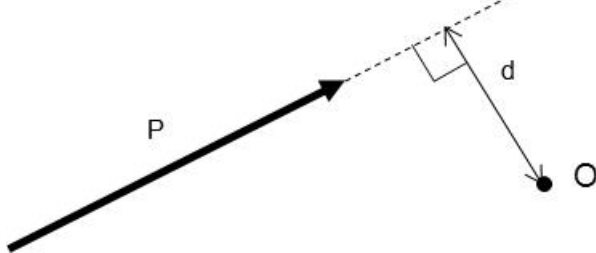
Q9. Forces 10 N, 15 N and 30 N act as shown below.



- (a) Compute the resultant in x.
- (b) Compute the resultant in y.

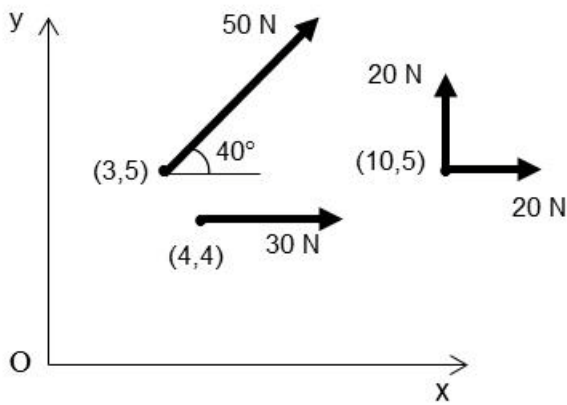
A9:
 (a) $R_x = 47.25 \text{ N}$
 (b) $R_y = 12.25 \text{ N}$

Q10. Compute and sketch the resultant force and moment of the force P shown below about the point O.



A10:
 $R = P$ (same direction)
 $M = P \cdot d$ (clockwise)

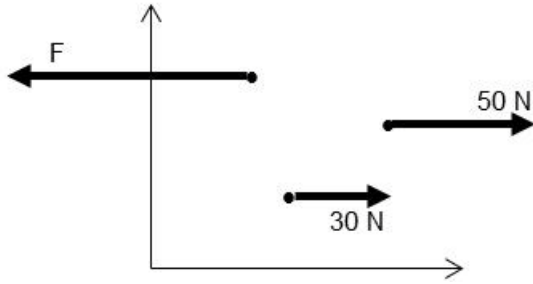
Q11. The force system shown below consists of several forces and moments in the xy plane. Compute the resultant forces in x and y and the moment about O (coordinates shown are in metres).



A11:
 (a) $R_x = 88.3 \text{ N}$
 (b) $R_y = 52.1 \text{ N}$
 (c) $M_o = 115.1 \text{ Nm}$

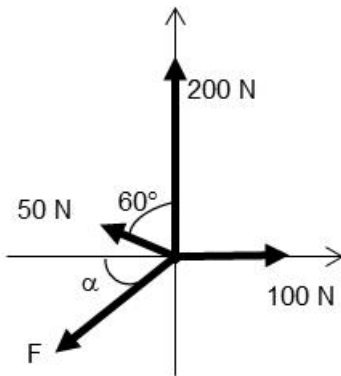
Q12. Determine the magnitude and direction of the forces (F, F1 etc.) which hold the systems of forces shown below in equilibrium.

(a)



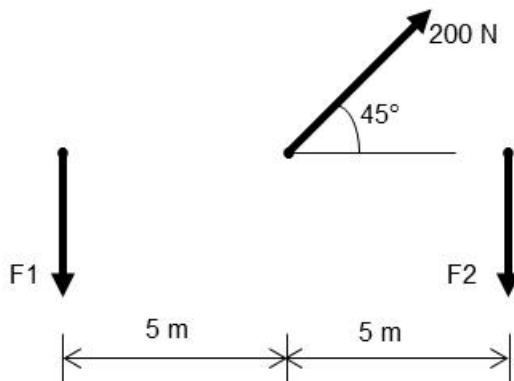
A12a:
 $F = 80\text{ N}$

(b)



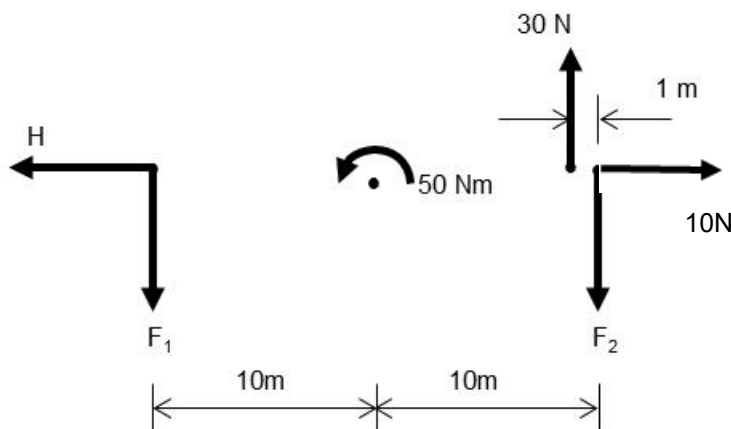
A12b:
 $F = 232\text{ N}$
 $\alpha = 75.8^\circ$

(c)



A12c:
 $F_1 = F_2 = 70.7\text{ N}$

(d)



A12d:
 $H = 10\text{ N}$
 $F_1 = -1\text{ N}$ (upwards)
 $F_2 = 31\text{ N}$