Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

4 Forces

Exercise B, Question 1

Question:

Find the magnitude of the resultant of the forces of magnitude F_1 and F_2, if θ is the angle between them. Also find the angle between the resultant and the force of magnitude F_1. Draw a diagram before starting each question.

(a) $F_1 = 4$ N , $F_2 = 3$ N , $\theta = 90°$

(b) $F_1 = 6$ N , $F_2 = 10$ N , $\theta = 60°$

(c) $F_1 = 7$ N , $F_2 = 9$ N , $\theta = 75°$

(d) $F_1 = 8$ N , $F_2 = 12$ N , $\theta = 170°$

(e) $F_1 = 10$ N , $F_2 = 11$ N , $\theta = 160°$

Solution:

(a) By Pythagoras' Theorem

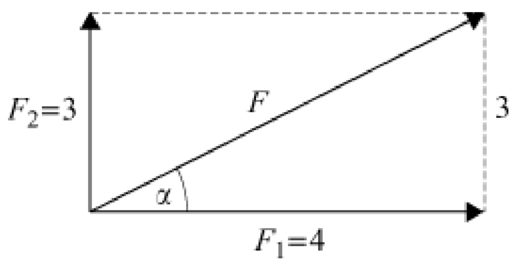
$$|F| = \sqrt{4^2 + 3^2}$$

$$\therefore \ |F| = 5 \text{ N}$$

$$\tan \alpha = \frac{3}{4}$$

$$\text{i.e. } \alpha = 36.869...°$$

i.e. at 36.9 ° with F_1 (3 s.f.).



(b) By cosine rule

$|F|^2 = 6^2 + 10^2 - 2 \times 6 \times 10 \times \cos 120°$

$|F|^2 = 196$

$\therefore |F| = 14$ N

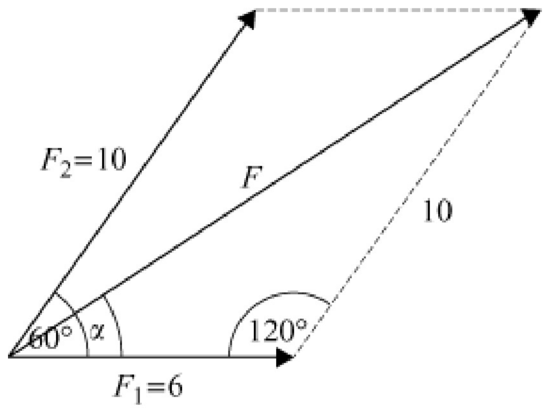
then sine rule $\frac{10}{\sin \alpha} = \frac{14}{\sin 120°}$

$\therefore \frac{\sin \alpha}{10} = \frac{\sin 120°}{14}$

i.e. $\sin \alpha = 10 \times \frac{\sin 120°}{14}$

gives $\alpha = 38.213...°$

i.e. at 38.2 ° with F_1 (3 s.f.)



(c) cosine rule

$|F|^2 = 7^2 + 9^2 - 2 \times 7 \times 9 \times \cos 150°$

$|F|^2 = 162.611...$

$\therefore |F| = 12.751...$

i.e. $|F| = 12.8$ N (3 s.f.)

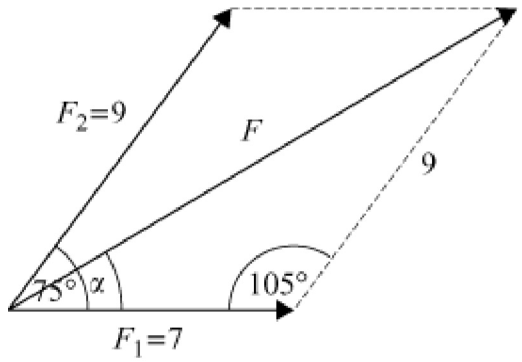
then sine rule $\frac{9}{\sin \alpha} = \frac{12.751...}{\sin 105°}$

i.e. $\frac{\sin \alpha}{9} = \frac{\sin 105°}{12.751...}$

gives $\sin \alpha = 9 \times \frac{\sin 105°}{12.751}$

i.e. $\alpha = 42.978...°$

i.e. at 43.0 ° with F_1 (3 s.f.)



(d) cosine rule

$|F|^2 = 8^2 + 12^2 - 2 \times 8 \times 12 \times \cos 10°$

$|F|^2 = 18.916...$

$\therefore |F| = 4.3493...$

i.e. $|F| = 4.35$ N (3 s.f.)

then cosine rule

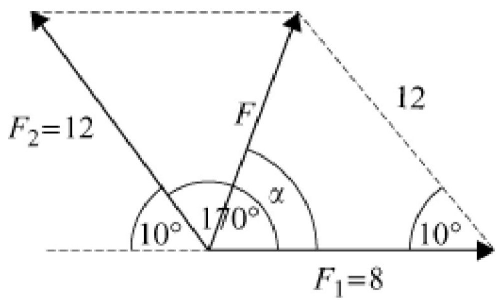
$12^2 = 4.3493...^2 + 8^2 - 2 \times 4.3493 \times 8 \times \cos \alpha$

gives $2 \times 4.3493 \times 8 \times \cos \alpha = 4.3493^2 + 8^2 - 12^2$

$\cos \alpha = \frac{(4.3493^2 + 8^2 - 12^2)}{(2 \times 4.3493 \times 8)}$

$\alpha = 151.37...°$

i.e. at 151 ° (3 s.f.) to F_1



(e) cosine rule

$|F|^2 = 10^2 + 11^2 - 2 \times 10 \times 11 \times \cos 20°$

$\therefore |F|^2 = 14.267...$

$\therefore |F| = 3.7772...$

i.e. $|F| = 3.78$ N (3 s.f.)

then cosine rule $11^2 = 3.7772...^2 + 10^2 - 2 \times 3.7772 \times 10 \times \cos \alpha$

$\therefore 2 \times 3.7772 \times 10 \times \cos \alpha = 3.7772^2 + 10^2 - 11^2$

$\therefore \cos \alpha = \frac{(3.7772^2 + 10^2 - 11^2)}{(2 \times 3.7772 \times 10)}$

$\alpha = 95.112...$

i.e. at 95.1 ° (3 s.f.) to F_1.