2021-09-30 Lecture 1.1

$$|F| = \sqrt{(-3)^2 + 5.2^2} = \frac{\sqrt{901}}{5} \simeq 6.0 \text{ N}$$

$$\tan\theta = \frac{o}{a}$$

$$\therefore \quad \theta = \tan^{-1}\frac{o}{a} = \tan^{-1}\frac{5.2}{3}$$

$$= 1.05 \text{ rad}$$

$F = 6.0$ N, 1.05 rad clockwise from horizontal (x)

Statics - Ex. Sheet 1, Part A

1.1) a) $F_x = 100\cos 45° = 50\sqrt{2} = 71$ N

$F_y = 100\sin 45° = 50\sqrt{2} = 71$ N

b) $F_x = -35\sin 60 = \frac{-35\sqrt{3}}{2} = -30$ N

$F_y = -35\cos 60 = -\frac{35}{2} = -17.5$ N

c) $F_x = -F\sin\theta$

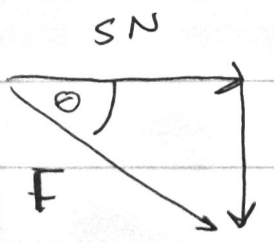
$F_y = F\cos\theta$

1.2) a) 100 N anti clockwise from horizontal

b) 35 N ~~anti~~ clockwise from ~~to~~ vertical

c) F N anti clockwise from vertical

1.3) $|F| = \sqrt{5^2 + 11^2} = \sqrt{146} = 12.1$ N



$\tan\theta = \frac{o}{a} \therefore \theta = \tan^{-1}\frac{11}{5}$

$= 65.6°$

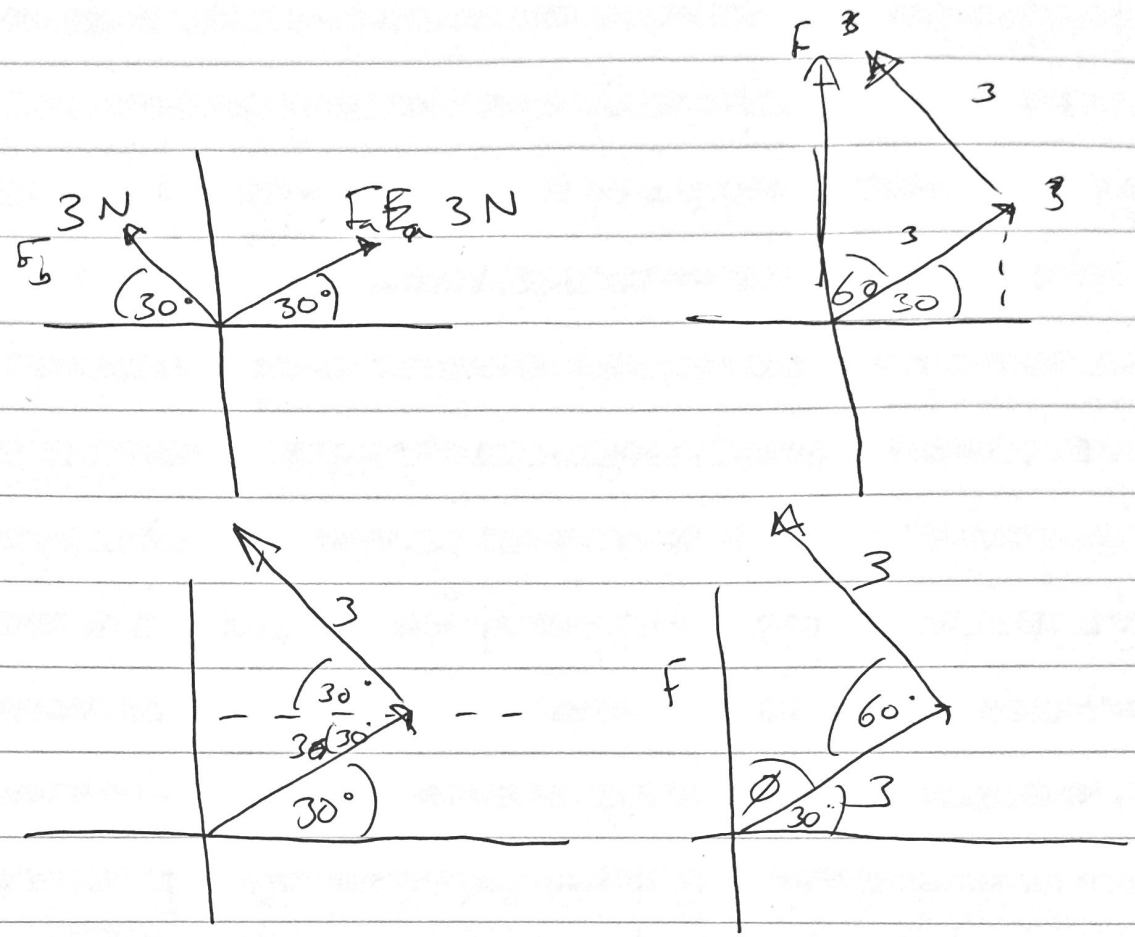
$F = 12.1$ N, $65.6°$ clockwise from horizontal

$$a^2 = b^2 + c^2 - 2bc\cos A$$

2021-10-01

Statics - Ex. Sheet 1, Part A

1.4)



$$|F|^2 = 3^2 + 3^2 - 2\times3\times3\times\cos 60$$

$$|F| = \sqrt{3^2+3^2-2\times3^2\cos 60}$$

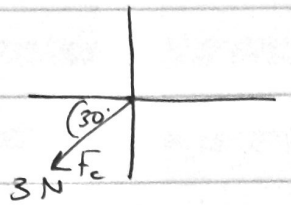
$$= 3$$

~~all sides~~ |any side| = 3 ∴ equilateral triangle

∴ $\emptyset = 60°$

∴ F = 3N vertically upwards

b) ~~$F_c - F_a = -3$~~



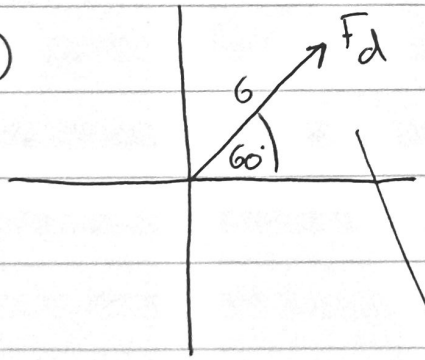
$$F_{cx} = -3\cos 30°$$
$$F_{cy} = -3\sin 30°$$

$$F_{bx} = -3\cos 30°$$
$$F_{by} = 3\sin 30°$$

$$F_b + F_c = \begin{pmatrix} F_{bx} + F_{cx} \\ F_{by} + F_{cy} \end{pmatrix} = \begin{pmatrix} -6\cos 30° \\ 0 \end{pmatrix}$$

$= 5.2$ N along -ve horizontal

c)



$$F_{dx} = 6\cos 60$$
$$F_{dy} = 6\sin 60$$

$$F_{ax} = -F_{cx} = 3\cos 30°$$
$$F_{ay} = -F_{cy} = 3\sin 30°$$

$$3F_b + 2F_d - F_a = 3\begin{pmatrix} -3\cos 30° \\ 3\sin 30° \end{pmatrix} + 2\begin{pmatrix} 6\cos 60 \\ 6\sin 60° \end{pmatrix} - \begin{pmatrix} 3\cos 30° \\ 3\sin 30° \end{pmatrix}$$

$$= \begin{pmatrix} -9\cos 30° + 12\cos 60° - 3\cos 30° \\ 9\sin 30° + 12\sin 60° - 3\sin 30° \end{pmatrix}$$

$$= \begin{pmatrix} 6 - 6 \\ 3 + 12\sin 60 \end{pmatrix} = \begin{pmatrix} 0 \\ 3 + 12\sin 60° \end{pmatrix}$$

c)

F_{ax}
F_{ay}

$$F_a = \begin{pmatrix} 3\cos 30 \\ 3\sin 30 \end{pmatrix} \quad F_b = \begin{pmatrix} -3\cos 30 \\ 3\sin 30 \end{pmatrix}$$

$$= \begin{pmatrix} 3\cos 30 \\ 1.5 \end{pmatrix} \quad = \begin{pmatrix} -3\cos 30 \\ 1.5 \end{pmatrix}$$

$$F_d = \begin{pmatrix} ~~6\cos 60~~ \; 3 \\ 6\sin 60 \end{pmatrix}$$

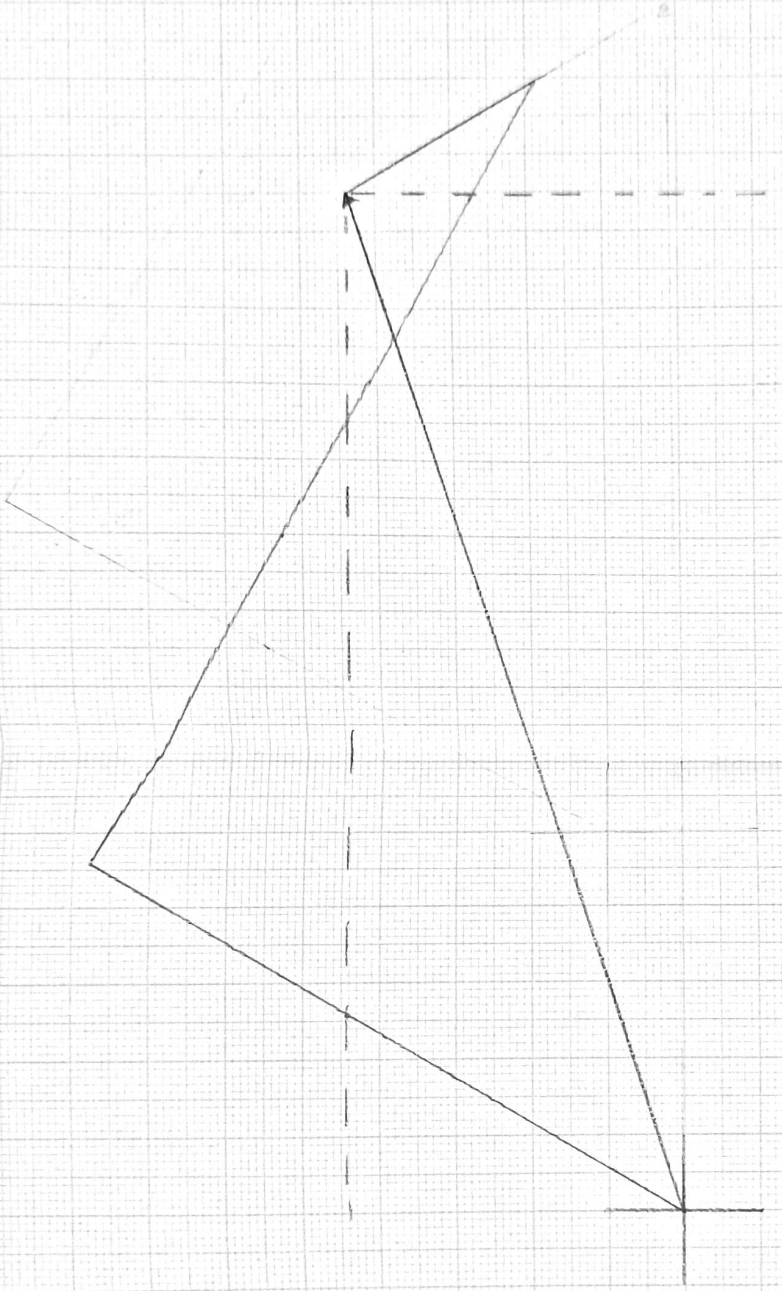
$$3F_b + 2F_d - F_a = 3\begin{pmatrix} -3\cos 30 \\ ~~3\sin 30~~ 1.5 \end{pmatrix} + 2\begin{pmatrix} 3 \\ 6\sin 60 \end{pmatrix} - \begin{pmatrix} 3\cos 30 \\ 1.5 \end{pmatrix}$$

$$= \begin{pmatrix} -9\cos 30 + 6 - 3\cos 30 \\ 4.5 + 12\sin 60 - 1.5 \end{pmatrix}$$

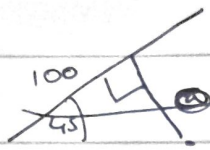
$$= \begin{pmatrix} 6 - 12\cos 30 \\ 3 + 12\sin 60 \end{pmatrix}$$

$$= \begin{pmatrix} -4.4 \\ 13.4 \end{pmatrix}$$

Ex 1.4) a)

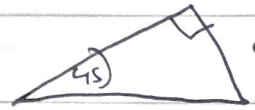


1.5) a)



$\cos\theta = \frac{o}{a}$

~~$100\cos 45 = o =$~~



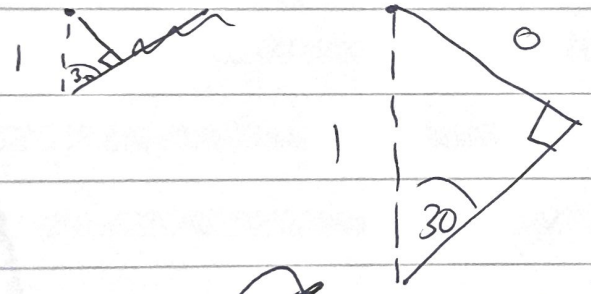
$\tan\theta = \frac{o}{a}$

$2\tan 45 = o$

$M = 100 \times 2\tan 45$

$= 200\,N_m$

b)



$\tan\theta = \frac{o}{a}$

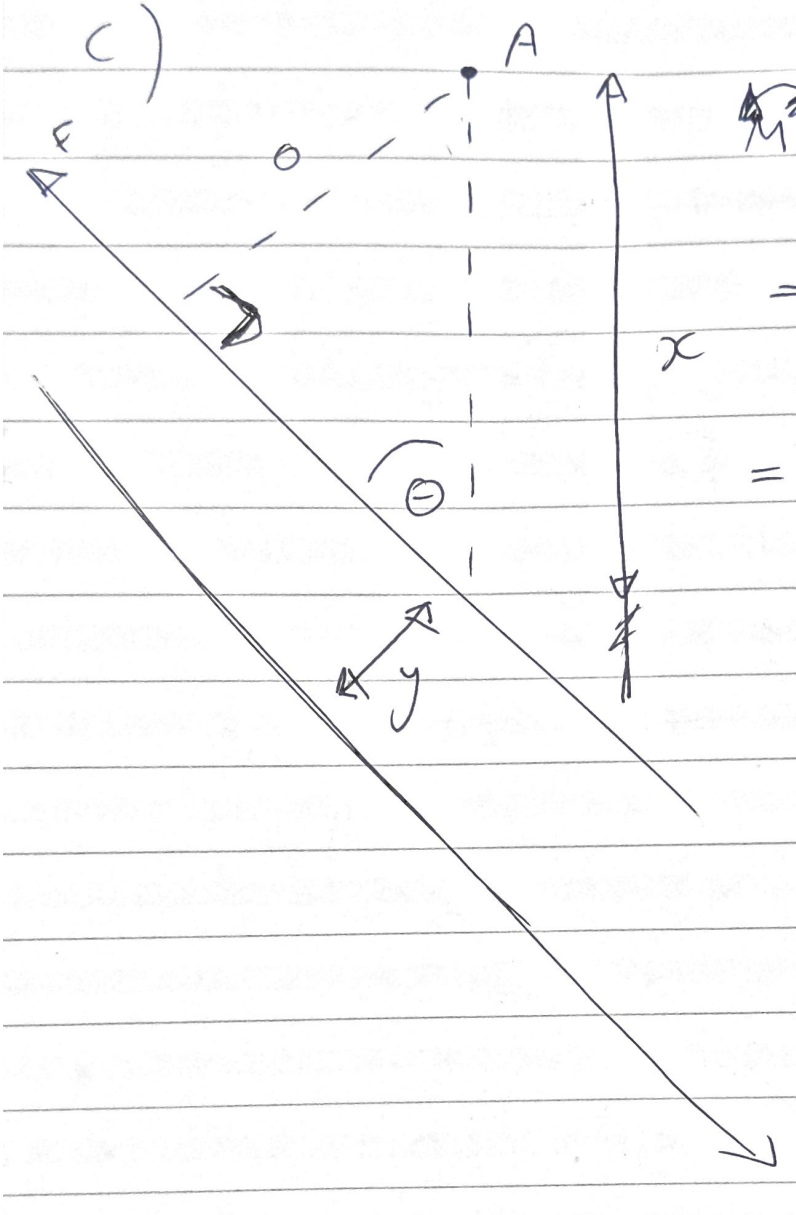
$\tan 30 = o$

$M = -35\tan 30$

$= -20.2\,N_m$

$\theta = a \tan \theta$

c)



$M_A = -F \times x \tan\theta$

$+ F \times (x \tan\theta + y)$

$= -F x \tan\theta + F x \tan\theta$

$+ F_y$

$= F_y \quad Nm$