Author: Manishaa Senthilkumaran

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10.2 Forces as Vectors

1) a) $(2i-4j)+(-i+5j)=(i+j)$ N

b) $\begin{pmatrix}4\\6\end{pmatrix}+\begin{pmatrix}-2\\-5\end{pmatrix}=\begin{pmatrix}2\\1\end{pmatrix}$ N

c) $(i-2j)+(4i-2j)+(-2i+6j)=(3i+2j)$ N

d) $\begin{pmatrix}-2\\5\end{pmatrix}+\begin{pmatrix}0\\7\end{pmatrix}+\begin{pmatrix}3\\-8\end{pmatrix}=\begin{pmatrix}1\\4\end{pmatrix}$ N

2) $\begin{pmatrix}3\\4\end{pmatrix}+\begin{pmatrix}2\\-3\end{pmatrix}+\begin{pmatrix}a\\b\end{pmatrix}=0$

$\begin{pmatrix}5+a\\1+b\end{pmatrix}=0$

$a=-5$
$b=-1$

3) $\begin{pmatrix}-2\\3\end{pmatrix}+\begin{pmatrix}5\\-6\end{pmatrix}+\begin{pmatrix}-6\\4\end{pmatrix}+\begin{pmatrix}a\\b\end{pmatrix}=0$

$\begin{pmatrix}-3+a\\1+b\end{pmatrix}=0$

$a=3$
$b=-1$

4) $\begin{pmatrix}a\\b\end{pmatrix}+\begin{pmatrix}8\\2b\end{pmatrix}+\begin{pmatrix}-3a\\-8\end{pmatrix}=0$

$\begin{pmatrix}8-2a\\-8+3b\end{pmatrix}=0$

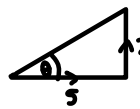
$8-2a=0$
$2a=8$
$a=4$

$-8+3b=0$
$3b=8$
$b=\frac{8}{3}$

$a=4$
$b=\frac{8}{3}$

5) a) i) $\sqrt{5^2+2^2}=\sqrt{29}$ N

ii)

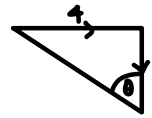


$\tan\theta=\frac{2}{5}$

$\tan^{-1}\left(\frac{2}{5}\right)=21.8°$

b) i) $\sqrt{(4)^2+(-3)^2}=5$ N

ii)

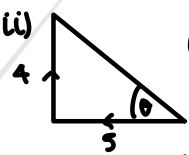


$\tan\theta=\frac{3}{4}$

$\tan^{-1}\left(\frac{3}{4}\right)=36.9°$

c) i) $\sqrt{(-5)^2+(4)^2}=\sqrt{41}$ N

ii)



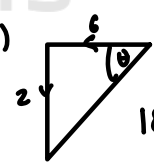
$\tan\theta=\frac{4}{5}$

$\tan^{-1}\left(\frac{4}{5}\right)=38.65$

$180-38.65=141.3°$

d) i) $\sqrt{(-6)^2+(-2)^2}=2\sqrt{10}$ N

ii)



$\tan\theta=\left(\frac{2}{6}\right)=18.4$

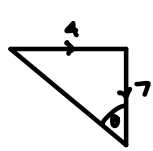
$180-18.4=161.6°$

6) a) i) $(5i-3j)+(2i+j)+(-3i-5j)$

$=(4i-7j)$ N

ii) $\sqrt{(4)^2+(-7)^2}=\sqrt{65}$ N

iii)



$\tan\theta=\frac{4}{7}$

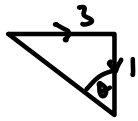
$\tan^{-1}\left(\frac{4}{7}\right)=29.7$

$180-29.7=150.3°$

b) i) $(3i+2j)+(-4i-5j)+(4i+2j)=(3i-j)N$

ii) $\sqrt{(3)^2+(-1)^2}=\sqrt{10}N$

iii)



$\tan\left(\frac{3}{1}\right)$

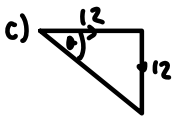
$\tan^{-1}(3)=71.6$

$180-71.6=108.4°$

b) $(16i+4j)+(-4i-16j)=(12i-12j)$

$\sqrt{(12)^2+(-12)^2}=12\sqrt{2}N$

c)



$\tan\theta=\frac{12}{12}$

$\tan^{-1}(1)=45°$

$180-45=135°$

7) a) $\begin{pmatrix}2a\\b\end{pmatrix}+\begin{pmatrix}b\\-a\end{pmatrix}+\begin{pmatrix}-11\\1\end{pmatrix}=0$

$\begin{pmatrix}2a+b-11\\-a+b+1\end{pmatrix}=0$

$2a+b=11$
$-a+b=-1$

$-\quad 2a+b=11$
$\quad -a+b=-1$
$\quad 3a=12$
$\quad a=4$

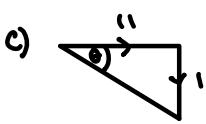
$2(4)+b=11$
$8+b=11$
$b=3$

$a=4$
$b=3$

b) $\begin{pmatrix}8\\3\end{pmatrix}+\begin{pmatrix}3\\-4\end{pmatrix}=\begin{pmatrix}11\\-1\end{pmatrix}$

$\sqrt{(11)^2+(-1)^2}=\sqrt{122}N$

c)



$\tan\theta=\left(\frac{1}{11}\right)$

$\tan^{-1}\left(\frac{1}{11}\right)=5.19$
$45°$

9) $R=(-4i+7j)+(2ai-aj)$

$R=k(3i+j)$

$(-4i+7j)+(2ai-aj)=k(3i+j)$

$(-4i+7j)+(2ai-aj)=3ki+kj$

$-4+2a=3k$
$7-a=k \times 2$

$+\quad -4+2a=3k$
$\quad 14-2a=2k$
$\quad 10=5k$
$\quad k=2$

$-4+2a=3(2)$
$-4+2a=6$
$2a=10$
$a=5$

8) a) $(4ai+aj)+(-26i-8bj)+(-12i+12j)=0$

$\begin{pmatrix}4a-26-12\\a-8b+12\end{pmatrix}=0$

$4a-26=12 \times 4$
$a-8b=-12$

$-\quad 16a-8b=48$
$\quad a-8b=-12$
$\quad 15a=60$
$\quad a=4$

$4(4)-26=12$
$16-26=12$

$2b=4$
$b=2$

$a=4$
$b=2$