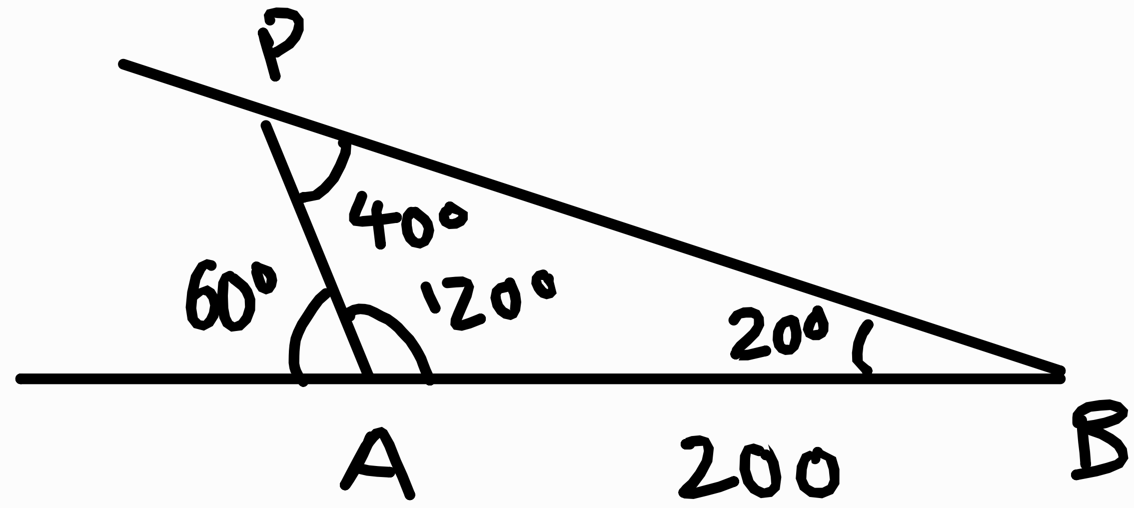
1) $\dfrac{200}{\sin 40^\circ} = \dfrac{PB}{\sin 120^\circ} = \dfrac{PA}{\sin 20^\circ}$



$$PB = \frac{200 \sin 120^\circ}{\sin 40^\circ}$$

$$PA = \frac{200 \sin 20^\circ}{\sin 40^\circ}$$

$$\vec{v}_P = \cancel{\vec{v}_{P/f}} + \vec{v}_{P'}$$

$$= \cancel{\vec{v}_A} + \vec{\omega}_{PA} \times \vec{r}_{PA}$$

$$= -6\underset{\sim}{k} \times \left(\frac{200 \sin 20^\circ}{\sin 40^\circ} \angle 120^\circ \right)$$

$$= \frac{1200 \sin 20^\circ}{\sin 40^\circ} \angle 30^\circ$$

$$\vec{v}_P = \vec{v}_{P/f_2} + \vec{v}_{P'}$$

$$= \vec{v}_{P/f_2} + \cancel{\vec{v}_B} + \vec{\omega}_{PB} \times \vec{r}_{PB}$$

$$= \vec{v}_{P/f_2} + \omega_{PB}\underset{\sim}{k} \times \left(\frac{200 \sin 120^\circ}{\sin 40^\circ} \angle 160^\circ \right)$$

$$= v_{P/f_2} \angle 160^\circ + \frac{200 \omega_{PB} \sin 120^\circ}{\sin 40^\circ} \angle 250^\circ$$

1) $\vec{v}_p = 552.963\underset{\sim}{i} + 319.253\underset{\sim}{j}$

$$\vec{v}_p = -0.9397 v_{p|f_2}\underset{\sim}{i} - 92.1605 w_{PB}\underset{\sim}{i}$$

$$+ 0.342 v_{p|f_2}\underset{\sim}{i} - 253.2089 w_{PB}\underset{\sim}{j}$$

Solving,

$v_{p|f_2} = -410.424172$

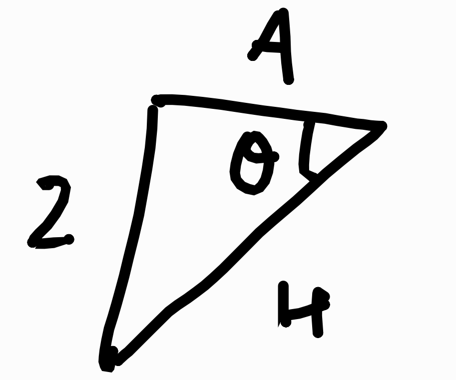
$w_{PB} = -1.815207469$

a) $\therefore \underset{\sim}{\vec{w}_{PB}} = -1.815207469\underset{\sim}{k}$ rads^{-1}

b) $\therefore \vec{v}_{p|f_2} = -410.424172 \angle 160^\circ$

$= 410.424172 \angle -20^\circ$

2) $\vec{v}_B = \vec{v}_{B|f} + \cancel{\vec{v}_{B'}} + \vec{\omega}_f \times \vec{r}_{BO}$



$$= -2\underset{\sim}{i} + 5\underset{\sim}{k} \times \left(\frac{2}{\tan\theta}\underset{\sim}{i} + 2\underset{\sim}{j}\right)$$

$$= -2\underset{\sim}{i} + \frac{10}{\tan\theta}\underset{\sim}{j} - 10\underset{\sim}{i}$$

$$= -12\underset{\sim}{i} + 10\cot\theta\underset{\sim}{j}$$

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

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

$i \; j \; k \; i \; j$

a) when $\theta = 90^\circ$, $\cot\theta = 0$

$\therefore \vec{v}_B = -12\underset{\sim}{i}$

b) when $\theta = 60^\circ$,

$$\vec{v}_B = -12i + 10\cot 60^\circ \underset{\sim}{j}$$

$$= -12i + 5.773502692\underset{\sim}{j}$$

3a) $\vec{v}_B = \vec{v}_{B/f} + \cancel{\vec{v}_{B'}} + \vec{\omega}_f \times \vec{r}_{BA}$

$= 0.15\angle -150^\circ - 0.075\underset{\sim}{k} \times (6\angle 30^\circ)$

$= 0.15\angle -150^\circ + 0.45\angle -60^\circ$

$= 0.0950961894\underset{\sim}{i} - 0.464711431\underset{\sim}{j}$

b) $\vec{a}_B = \cancel{\vec{a}_{B/f}} + \vec{a}_{B'} + 2\vec{\omega}_f \times \vec{v}_{B/f}$

$= \cancel{\vec{\alpha} \times \vec{r}_{BA}} - \omega^2 \vec{r}_{BA} + 2(-0.075\underset{\sim}{k}) \times 0.15\angle -150^\circ$

$= -(-0.075)^2\, 6\angle 30^\circ + 0.0225\angle -240^\circ$

$= 0.03375\angle -150^\circ + 0.0225\angle 120^\circ$

$= -0.0404783573\underset{\sim}{i} + 0.0026105715\underset{\sim}{j}$

4) Let G be the mid point of CD.

a) $\vec{v}_B = \vec{v}_{B/f} + \vec{v}_{B'} + \cancel{\vec{w}_f \times \vec{r}_{BG}}$

$i \; j \; k \; i \; j$

$= 375\underset{\sim}{i} + \cancel{\vec{v}_A} + \vec{w} \times \vec{r}_{BA}$

$= 375\underset{\sim}{i} + 0 - 2.4\underset{\sim}{k} \times (-250\underset{\sim}{i} - 188\underset{\sim}{j})$

$= -76.2\underset{\sim}{i} + 600\underset{\sim}{j}$

b) $\vec{a}_B = \cancel{\vec{a}_{B/f}} + \vec{a}_{B'} + 2\vec{w}_f \times \vec{v}_{B/f}$

$= \cancel{\vec{a}_A} + \cancel{\vec{\alpha} \times \vec{r}_{BA}} - w^2 \vec{r}_{BA} - 2(2.4)\underset{\sim}{k} \times (375\underset{\sim}{i})$

$= -(-2.4)^2(-250\underset{\sim}{i} - 188\underset{\sim}{j}) - 1800\underset{\sim}{j}$

$= 1440\underset{\sim}{i} - 717.12\underset{\sim}{j}$

5a) $\vec{v}_p = \vec{v}_{p/f} + \vec{v}_{p'} + \cancel{\vec{w}_f \times \vec{r}_{PO''}}$

$= 10\angle -60^\circ + \cancel{\vec{v}_0} + \vec{w} \times \vec{r}_{PO}$

$= 10\angle -60^\circ + 0.3\underset{\sim}{k} \times (20\sqrt{3}\angle -60^\circ)$

$= 10\angle -60^\circ + 6\sqrt{3}\angle 30^\circ$

$= 14\underset{\sim}{i} - 3.46101615\underset{\sim}{j}$

b) $\vec{a}_p = \vec{a}_{p/f} + \vec{a}_{p'} + 2\vec{w}_f \times \vec{v}_{p/f}$

$= \vec{a}_{p/f} + \cancel{\vec{a}_0} + \cancel{\vec{\alpha} \times \vec{r}_{PO}} - w^2 \vec{r}_{PO} + 2\vec{w}_f \times \vec{v}_{p/f}$

$= -(0.3)^2(20\sqrt{3}\angle -60^\circ) + 2(0.3\underset{\sim}{k}) \times (10\angle -60^\circ)$

$\vec{a}_{p/f}{}^n + \cancel{\vec{a}_{p/f}{}^t}$

$a^n = \frac{v^2}{r}$

$= 1.8\sqrt{3}\angle 120^\circ + 6\angle 30^\circ + \frac{10^2}{20}\angle -150^\circ$

$= 1.8\sqrt{3}\angle 120^\circ + 6\angle 30^\circ + 5\angle -150^\circ$

$= -0.69282032\underset{\sim}{i} + 3.2\underset{\sim}{j}$