1) $\vec{v}_T = 60\underset{\sim}{i}$

$\vec{v}_A = 45(\cos 45^\circ \underset{\sim}{i} + \sin 45^\circ \underset{\sim}{j})$

$\vec{v}_{T/A} = \vec{v}_T - \vec{v}_A$

$= 60\underset{\sim}{i} - 45(\cos 45^\circ \underset{\sim}{i} + \sin 45^\circ \underset{\sim}{j})$

$= 28.18\underset{\sim}{i} - 31.8198\underset{\sim}{j}$

$= 42.50439252\angle -48.47131824^\circ$

$\approx 42.5 \angle -48.47^\circ$

2a) $\vec{v}_A = 15\angle 150^\circ$

$\vec{v}_T = 40\angle 90^\circ$

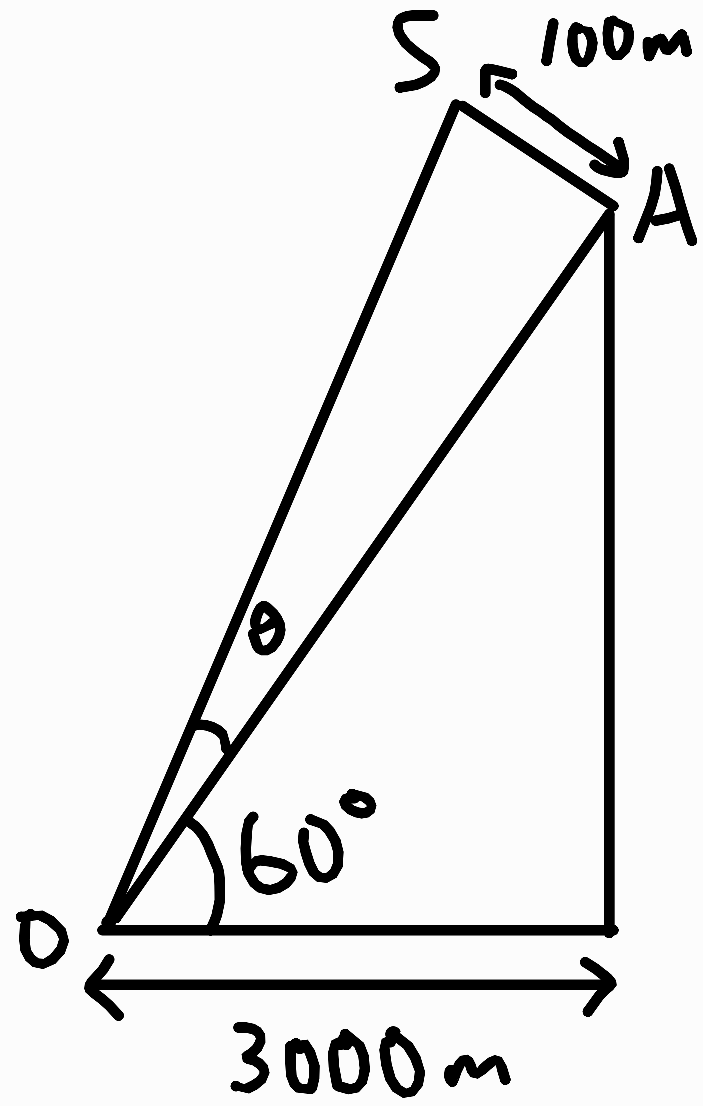
$\vec{v}_{T/A} = 40(\cos 90^\circ \underset{\sim}{i} + \sin 90^\circ \underset{\sim}{j}) - 15(\cos 150^\circ \underset{\sim}{i} + \sin 150^\circ \underset{\sim}{j})$

$= 12.99\underset{\sim}{i} + 32.5\underset{\sim}{j}$

$= 35\angle 68.2132107^\circ$

$\approx 35\angle 68.21^\circ$

2b)



$$\cos 60° = \frac{3000}{OA}$$

$$OA = \frac{3000}{\cos 60°}$$

$$\tan\theta = \frac{100}{OA}$$

$$= \frac{100\cos 60°}{3000}$$

$$\therefore \quad \theta = \arctan \frac{100\cos 60°}{3000}$$

$$= 0.9548412539°$$

$$60 + 0.9548412539$$

$$= 60.9548412539° < 68.21°$$

Since $60.95° < 68.21°$,

the torpedo will not hit the freighter.

3) $\vec{a}_A = 0.6 \angle 120^\circ$

$\vec{a}_B = 0.9 \angle 45^\circ$

$$\vec{a}_{A/B} = 0.6(\cos 120^\circ \underset{\sim}{i} + \sin 120^\circ \underset{\sim}{j}) - 0.9(\cos 45^\circ \underset{\sim}{i} + \sin 45^\circ \underset{\sim}{j})$$

$$= -0.9364\underset{\sim}{i} - 0.11678\underset{\sim}{j}$$

$$= 0.9436500576 \angle 187.1088305^\circ$$

$$s_{A/B} = \frac{1}{2}|\vec{a}_{A/B}|t^2$$

$$240 = \frac{1}{2}(0.9436500576)t^2$$

$$t = 22.55356155\,s$$

$$\approx 22.6\,s$$

$$\vec{v}_{A/B} = \vec{a}_{A/B}\,t$$

$$= 22.6(0.9436500576) \angle 187.1088305^\circ$$

$$= 21.28266966 \angle 187.1088305^\circ$$

$$\approx 21.283 \angle 187.11^\circ$$

4) Let $\vec{x}_A$ and $\vec{x}_B$ be the distance of A and B away from the rightmost side respectively.

$$\vec{x}_A + 2\vec{x}_B = \text{constant}$$

$$\vec{v}_A + 2\vec{v}_B = 0$$

$$\vec{v}_{A/B} = \vec{v}_A - \vec{v}_B$$

$$450 = \vec{v}_A - \vec{v}_B$$

$$450 + 3\vec{v}_B = \vec{v}_A + 2\vec{v}_B$$

$$3\vec{v}_B = -450$$

$$\vec{v}_B = -150 \text{ mms}^{-1}$$

a)

$$\vec{v}_B = \vec{a}_B t$$

$$-150 = \vec{a}_B(6)$$

$$\vec{a}_B = -25 \text{ mms}^{-2}$$

$$\vec{v}_A + 2\vec{v}_B = 0$$

$$\vec{a}_A(6) - 2(150) = 0$$

$$\vec{a}_A = \frac{300}{6}$$

$$\vec{a}_A = 50 \text{ mms}^{-2}$$

4b) $\vec{v}_B = \vec{a}_B(8)$

$= -25(8)$

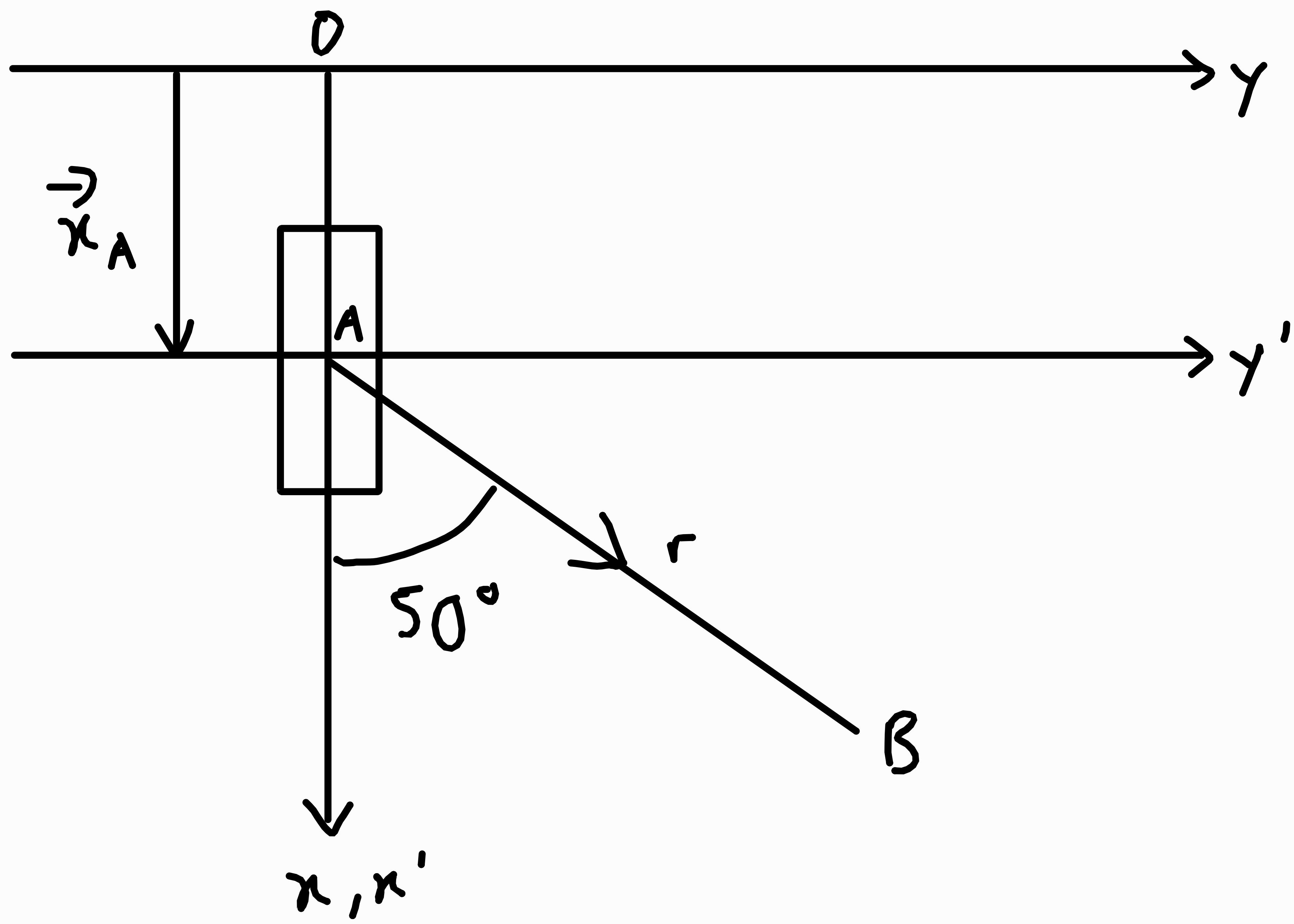
$= -200 \text{ mms}^{-1}$

$\vec{x}_B = \frac{1}{2}\vec{a}_B t^2$

$= \frac{1}{2}(-25)(8)^2$

$= -800 \text{ mm}$

5a)



Given $v_A = 225$, $a_A = 375$,

$\vec{v}_A = 225\underset{\sim}{i}$, $\vec{a}_A = 375\underset{\sim}{i}$

5a) Observed from $A-x'y'$,

$$\vec{v}_{B/A} = \dot{r}(\cos 50^\circ \underset{\sim}{i} + \sin 50^\circ \underset{\sim}{j})$$

$$\vec{a}_{B/A} = \ddot{r}(\cos 50^\circ \underset{\sim}{i} + \sin 50^\circ \underset{\sim}{j})$$

Constraint equation:

$$x_A + 2r = \text{constant}$$

$$v_A + 2\dot{r} = 0$$

$$a_A + 2\ddot{r} = 0$$

$$\therefore \dot{r} = -\frac{v_A}{2}$$

$$= -\frac{225}{2}$$

$$= -112.5 \text{ mms}^{-1}$$

$$\ddot{r} = \frac{-a_A}{2}$$

$$= -\frac{375}{2}$$

$$= -187.5 \text{ mms}^{-2}$$

5a) $\vec{v}_B = \vec{v}_{B/A} + \vec{v}_A$

$= -112.5(\cos 50^\circ \underset{\sim}{i} + \sin 50 \underset{\sim}{j}) + 225 \underset{\sim}{i}$

$= 152.686 \underset{\sim}{i} - 86.18 \underset{\sim}{j}$

$= 175.3286265 \angle -29.44146394$

$\approx 175.33 \angle -29.44^\circ$

b) $\vec{a}_B = \vec{a}_{B/A} + \vec{a}_A$

$= -187.5(\cos 50^\circ \underset{\sim}{i} + \sin 50^\circ \underset{\sim}{j}) + 375$

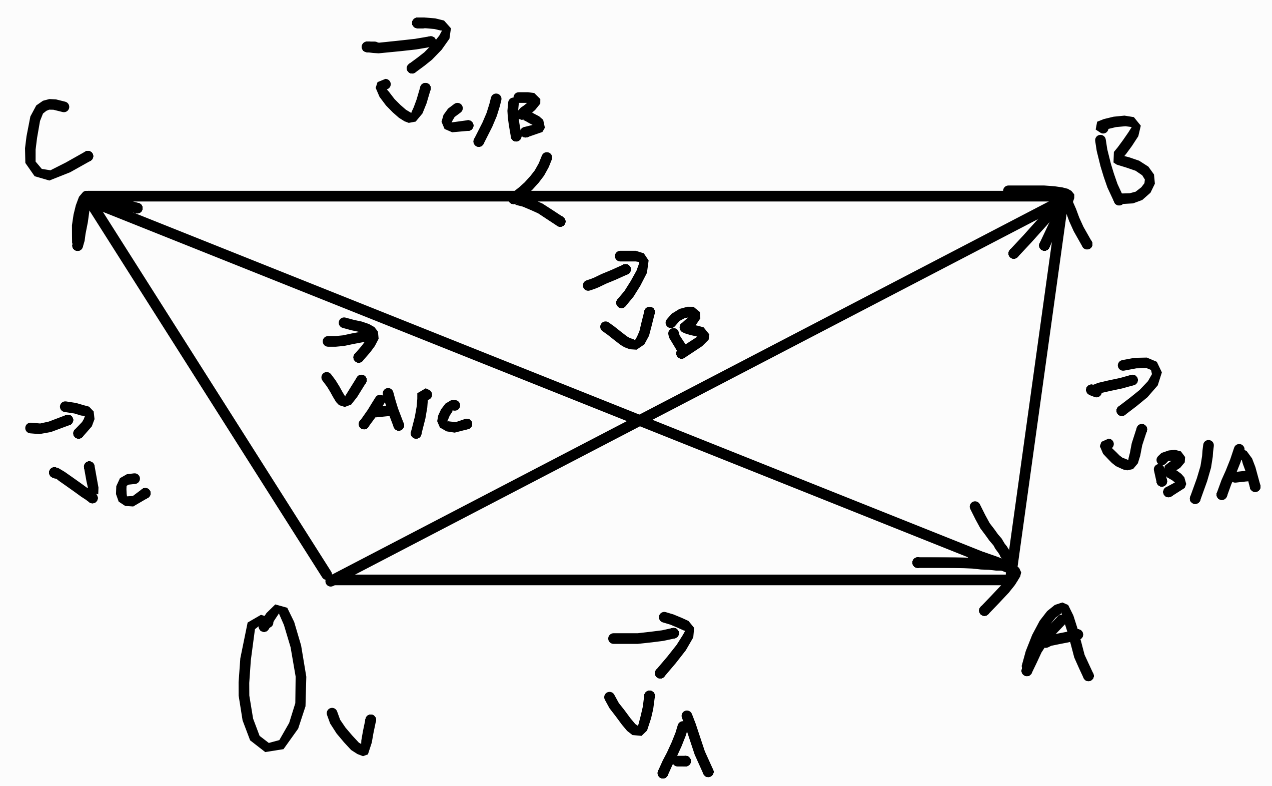
$= 254.4773232 \underset{\sim}{i} - 143.63 \underset{\sim}{j}$

$= 292.2143774 \angle -29.44146394^\circ$

$\approx 292.21 \angle -29.44^\circ$

6a) Graphical method:

1. Starting from O_v, draw $\vec{v}_A$ to determine point A and from A draw $\vec{v}_{B/A}$ to determine point B, then connect O_v to B to determine $\vec{v}_B$.
2. Starting from O_v, draw $\vec{v}_c$ to determine point C.
3. Connect C to A to get $\vec{v}_{A/C}$, Connect B to C to get $\vec{v}_{C/B}$



Analytical method:

$$\vec{v}_{A/C} = \vec{v}_A - \vec{v}_c$$

$$= 1.8\underset{\sim}{i} - 1.5(\cos 120^\circ \underset{\sim}{i} + \sin 120^\circ \underset{\sim}{j})$$

$$= 2.55\underset{\sim}{i} - 1.299\underset{\sim}{j}$$

$$= 2.861817604 \angle -26.995084$$

$$\approx 2.862 \angle -27.0^\circ$$

6a) $\vec{v}_B = \vec{v}_{B/A} + \vec{v}_A$

$= 1.2(\cos 50^\circ \underset{\sim}{i} + \sin 50 \underset{\sim}{j}) + 1.8\underset{\sim}{i}$

$= 2.571345132\underset{\sim}{i} + 0.9192533317\underset{\sim}{j}$

$\vec{v}_{c/B} = \vec{v}_c - \vec{v}_B$

$= 1.5(\cos 120^\circ \underset{\sim}{i} + \sin 120^\circ \underset{\sim}{j}) - 2.571345132\underset{\sim}{i}$

$- 0.9192533317\underset{\sim}{j}$

$= -3.321345132\underset{\sim}{i} - 0.3797847739\underset{\sim}{j}$

$= 3.342988178 \angle 173.4767505^\circ$

$\approx 3.343 \angle 173.48^\circ$

b) $\vec{v}_{B/C} = -\vec{v}_{c/B}$

$s_{c/B} = -\vec{v}_{c/B}\, t$

$= -3.343 \angle 173.48^\circ (10)$

$= 33.43 \angle -6.52^\circ$

c) $\vec{v}_{B/A} + \vec{v}_{c/B} + \vec{v}_{A/C}$

$= \cancel{\vec{v}_B} \cancel{- \vec{v}_A} \cancel{+ \vec{v}_c} \cancel{- \vec{v}_B} + \cancel{\vec{v}_A} \cancel{- \vec{v}_c}$

$= 0$ (shown