2. Two boats A and B having same speed relative to river are moving in a river. Boat A moves normal to the river current as observed by an observer moving with velocity of river current. Boat B moves normal to the river as observed by the observer on the ground.

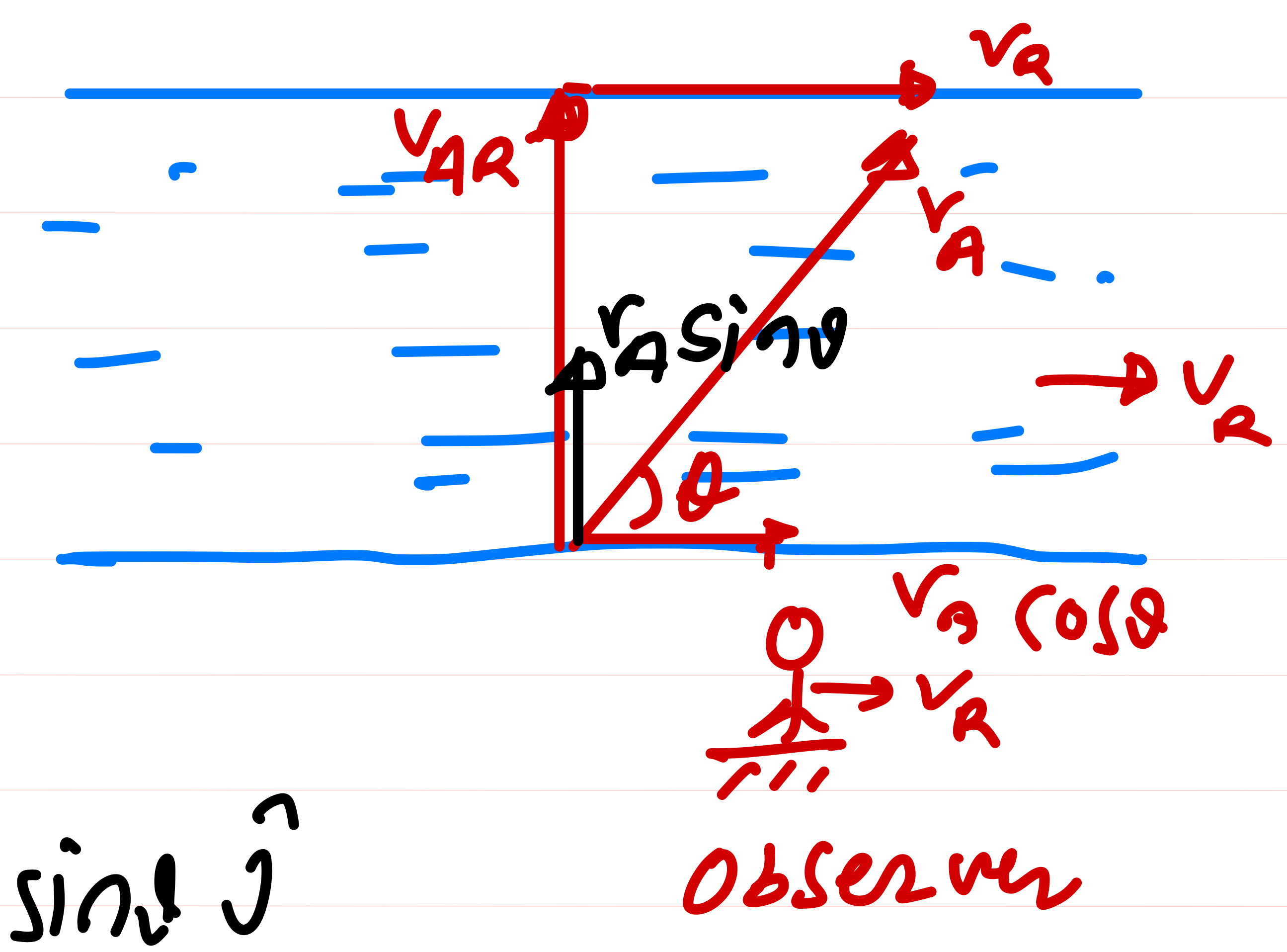
(A) To a ground observer boat B moves faster than A

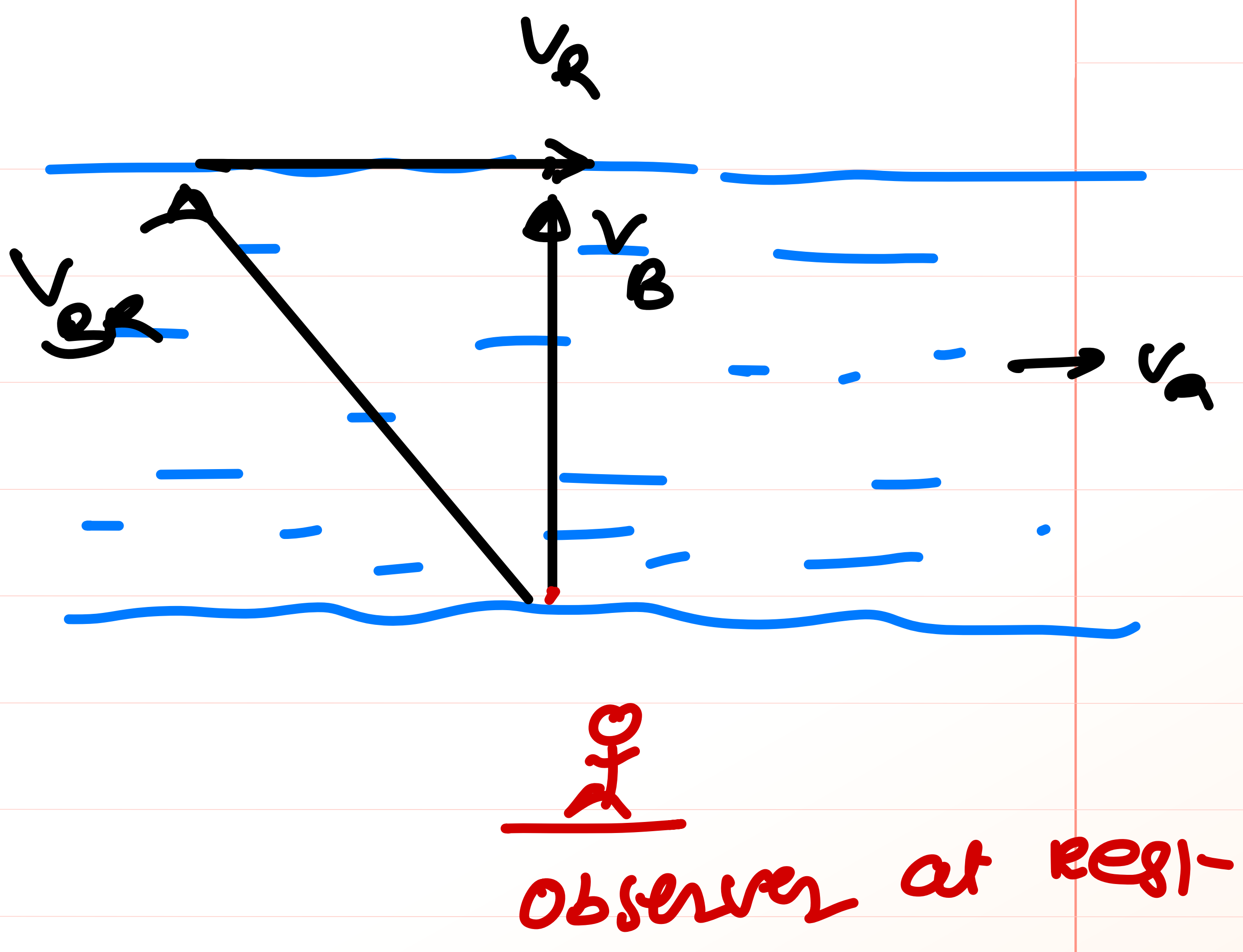
(B) To a ground observer boat A moves faster than B ✓

(C) To the given moving observer boat B moves faster than A

(D) To the given moving observer boat A moves faster than B

$\because V_{AR} = V_{BR}$





$$\vec{V}_A = V_A \cos\theta\,\hat{i} + V_A \sin\theta\,\hat{j}$$

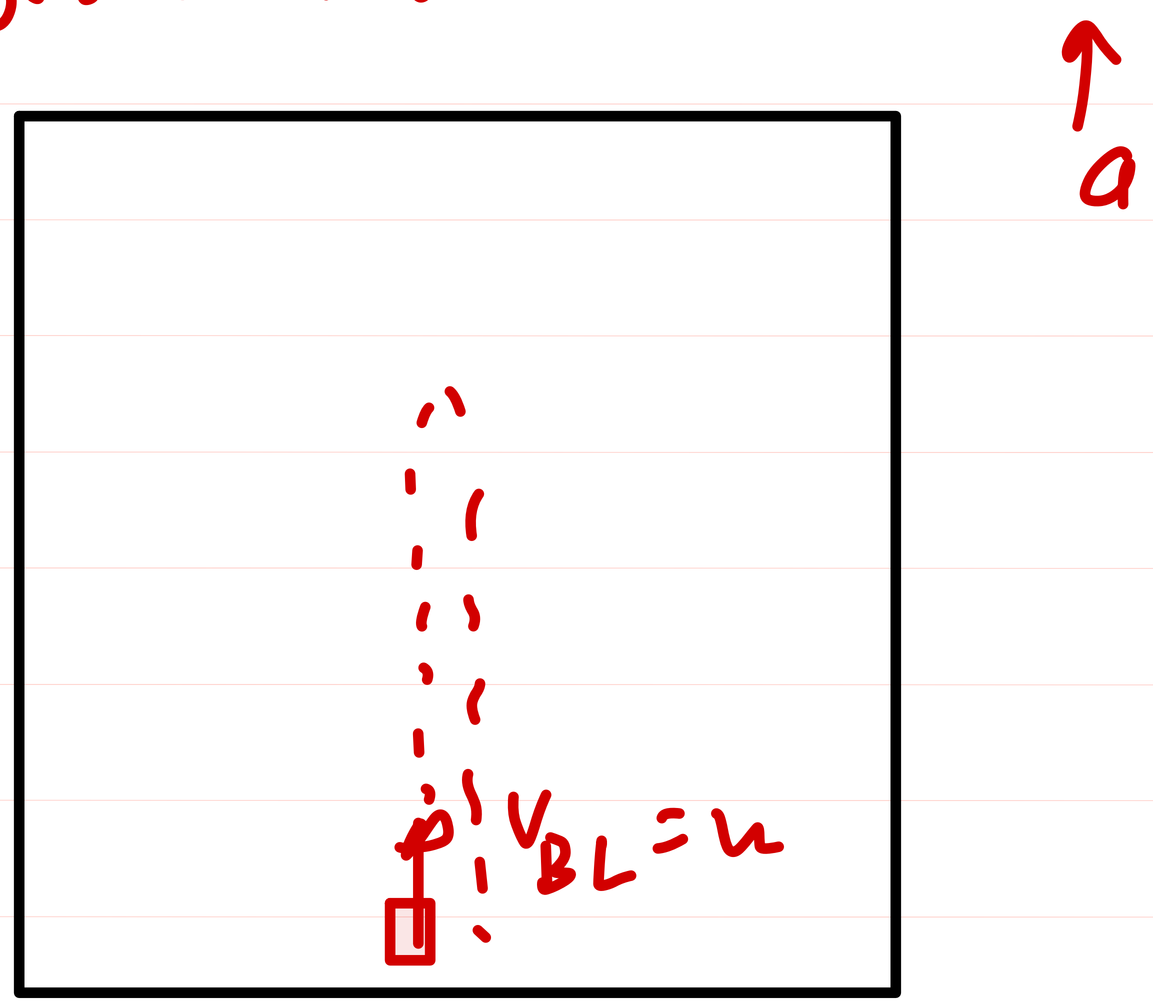
$$\vec{V}_B = V_B\,\hat{j}$$

11 A body is thrown up in a lift with a velocity u relative to the lift and the time of flight is found to be 't'. The acceleration with which the lift is moving up is :

(A) $\frac{u-gt}{t}$ (B) $\frac{2u-gt}{t}$ (C) $\frac{u+gt}{t}$ (D) $\frac{2u+gt}{t}$

motion w.r.t lift

Rest



$V_{BL} = u$

$a_{BL} = a_B - a_L$

$= (-g) - a$

$a_{BL} = -(g+a)$

$S_{BL} = 0 = u_{BL} t + \frac{1}{2} a_{BL} t^2$

$0 = ut - \left(\frac{g+a}{2}\right) t^2$

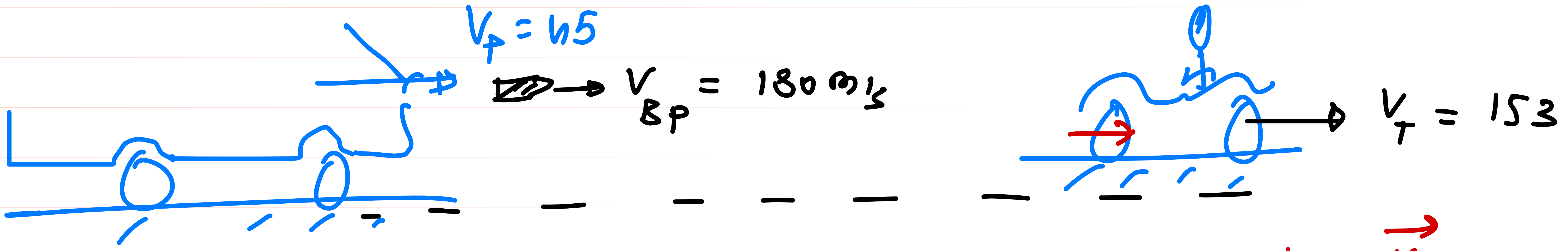
$u\cancel{t} = \frac{g+a}{2} t^{\cancel{2}}$

$\frac{2u}{t} = g + a$

$a = \frac{2u}{t} - g$

22. A police jeep is chasing with, velocity of 45 km/h a thief in another jeep moving with velocity 153 km/h. Police fires a bullet with muzzle velocity of 180 m/s. The velocity it will strike the car of the thief is

(A) 150 m/s (B) 27 m/s (C) 450 m/s (D) 250 m/s



$$V_{BP} = V_B - V_P$$

$$\vec{V_B} = \vec{V_{BP}} + \vec{V_P}$$

$$\vec{V_B} = 180 + 45 \times \frac{5}{18}$$

$$\vec{V_{BT}} = \vec{V_B} - \vec{V_T}$$

$$= 180 + 45 \times \frac{5}{18} - \frac{153 \times 5}{18}$$

$$\boxed{V_{BT} = 150 \text{ m/s}}$$ Ans

3. A boat is moving with a velocity $3\hat{i}+4\hat{j}$ with respect to the ground. The water in the river is flowing with a velocity $-3\hat{i}-4\hat{j}$ with respect to the ground. The velocity of the boat relative to the water is

(A) $6\hat{i}+8\hat{j}$ (B) $8\hat{i}+6\hat{j}$ (C) $6\hat{i}+6\hat{j}$ (D) none of these

$$\vec{V}_B = 3\hat{i}+4\hat{j}$$

$$\vec{V}_R = -3\hat{i}-4\hat{j}$$

$$\vec{V}_{BR} = \vec{V}_B - \vec{V}_R$$

$$= (3\hat{i}+4\hat{j}) - (-3\hat{i}-4\hat{j})$$

$$= 6\hat{i}+8\hat{j}$$

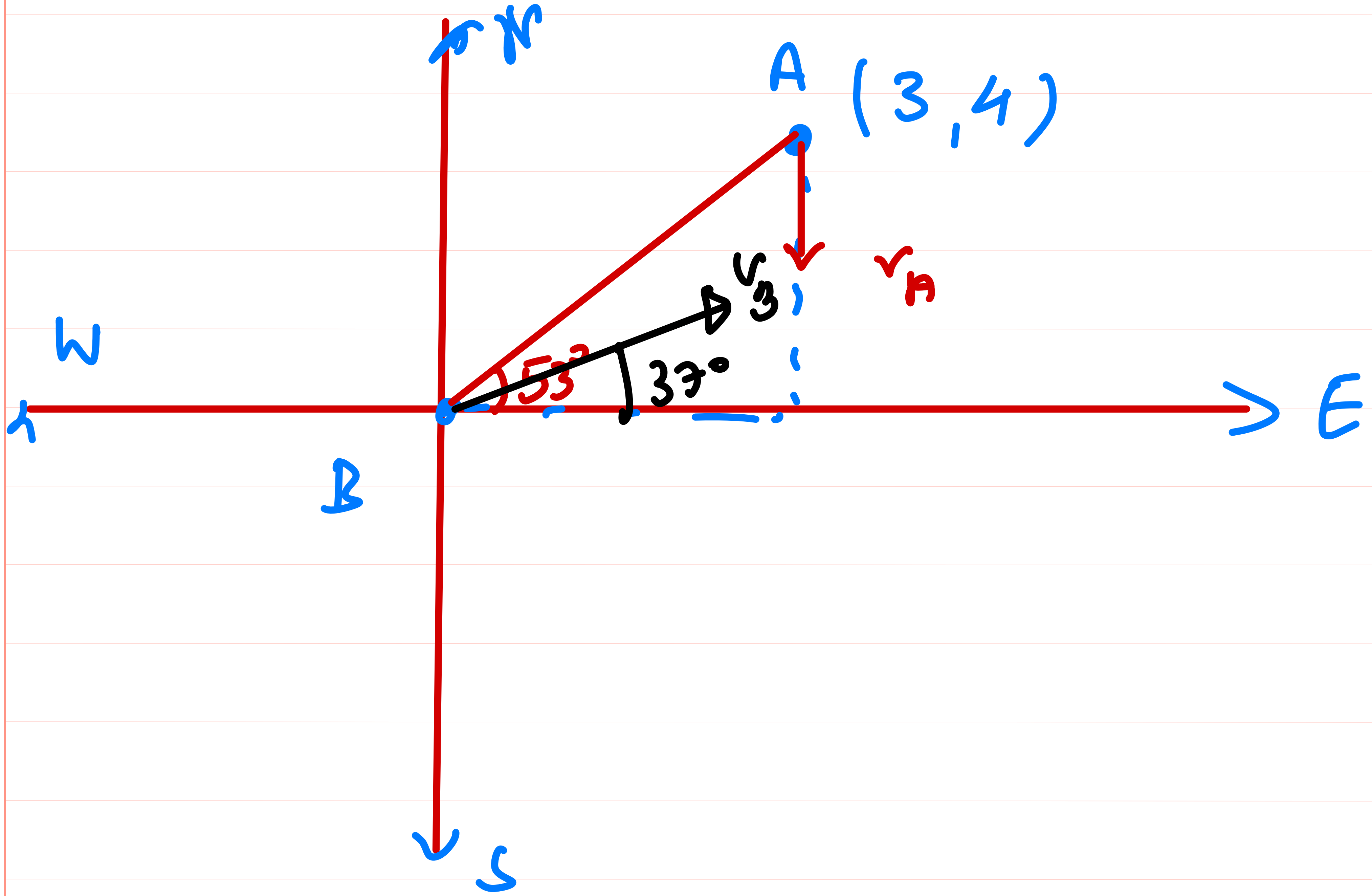
5. Ship A is located 4 km north and 3 km east of ship B. Ship A has a velocity of 20 kmh^{-1} towards the south and ship B is moving at 40 kmh^{-1} in a direction 37° north of east. Take x-and y-axes along east and north directions, respectively.

(A) Velocity of A relative to B is $-32\,\hat{i} - 44\,\hat{j}$.

(B) Position of A relative to B as a function of time is given by $\vec{r}_{AB} = (3-32t)\hat{i} + (4-44t)\hat{j}$ where t = 0 when the ships are in position described above.

(C) Velocity of B relative to A is $-32\hat{i} - 44\hat{j}$

(D) At some moment A will be west of B.



$\vec{V}_A = -20\hat{j}$ —— (1)

$\vec{V}_B = V_B\cos 37\,\hat{i} + V_B \sin 37\,\hat{j}$

$= 40 \times \frac{4}{5}\hat{i} + 40 \times \frac{3}{5}\hat{j}$

$\vec{V}_B = 32\hat{i} + 24\hat{j}$ —— (2)

$\vec{V}_{AB} = -20\hat{j} - 32\hat{i} - 24\hat{j}$

$\vec{V}_{AB} = -32\hat{i} - 44\hat{j}$

$\frac{d\vec{r}_{AB}}{dt} = -32\hat{i} - 44\hat{j}$

$\int_{\vec{r}_i}^{\vec{r}_f} d\vec{r}_{AB} = -32t\hat{i} - 44t\hat{j}$

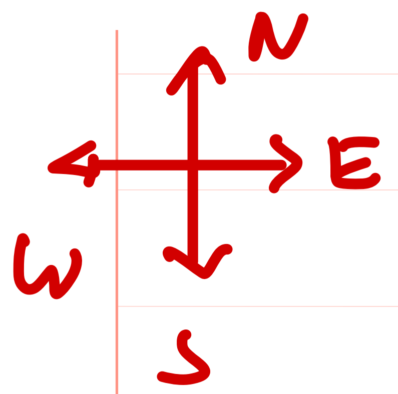
$\vec{r}_f - \vec{r}_i = -32t\hat{i} - 44t\hat{j}$

$\vec{r}_i = 3\hat{i} + 4\hat{j}$

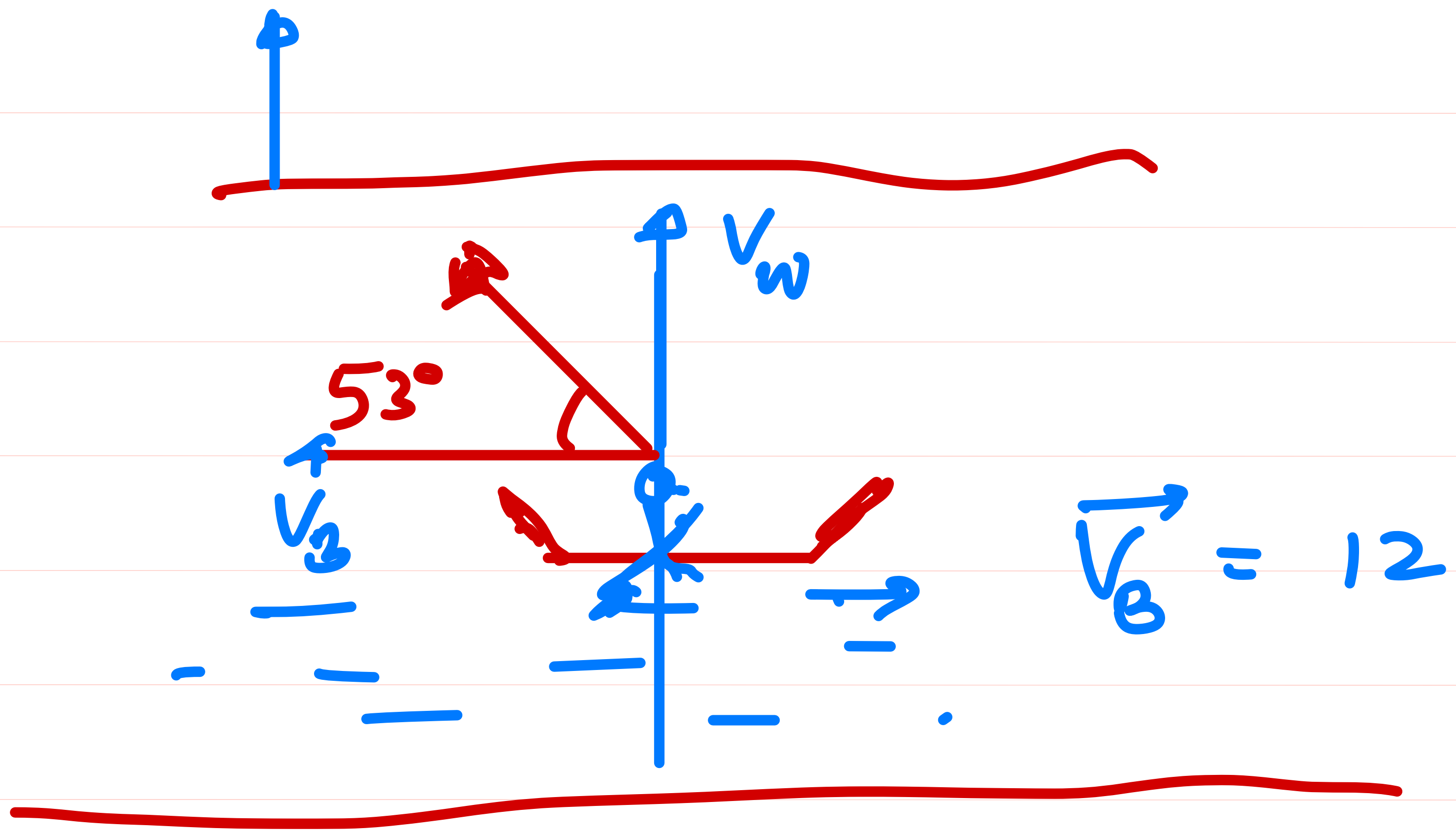
7. A boat is traveling due east at 12 ms^{-1}. A flag on the boat flaps at 53°N of W. Another flag on the shore flaps due north.

(A) Speed of wind with respect to ground is 16 ms^{-1} (B) Speed of wind with respect to ground is 20 ms^{-1}

(C) Speed of wind with respect to boat is 20 ms^{-1} (D) Speed of wind with respect to boat is 16 ms^{-1}



$\vec{V}_w = V_w \hat{j}$



$\vec{V}_B = 12\hat{i}$

$\tan 53 = \dfrac{V_w}{V_B}$

$\dfrac{4}{3} \times 12 = V_w$

$16\ m/s = V_w$

$\vec{V}_{WB} = \vec{V}_w - \vec{V}_B$

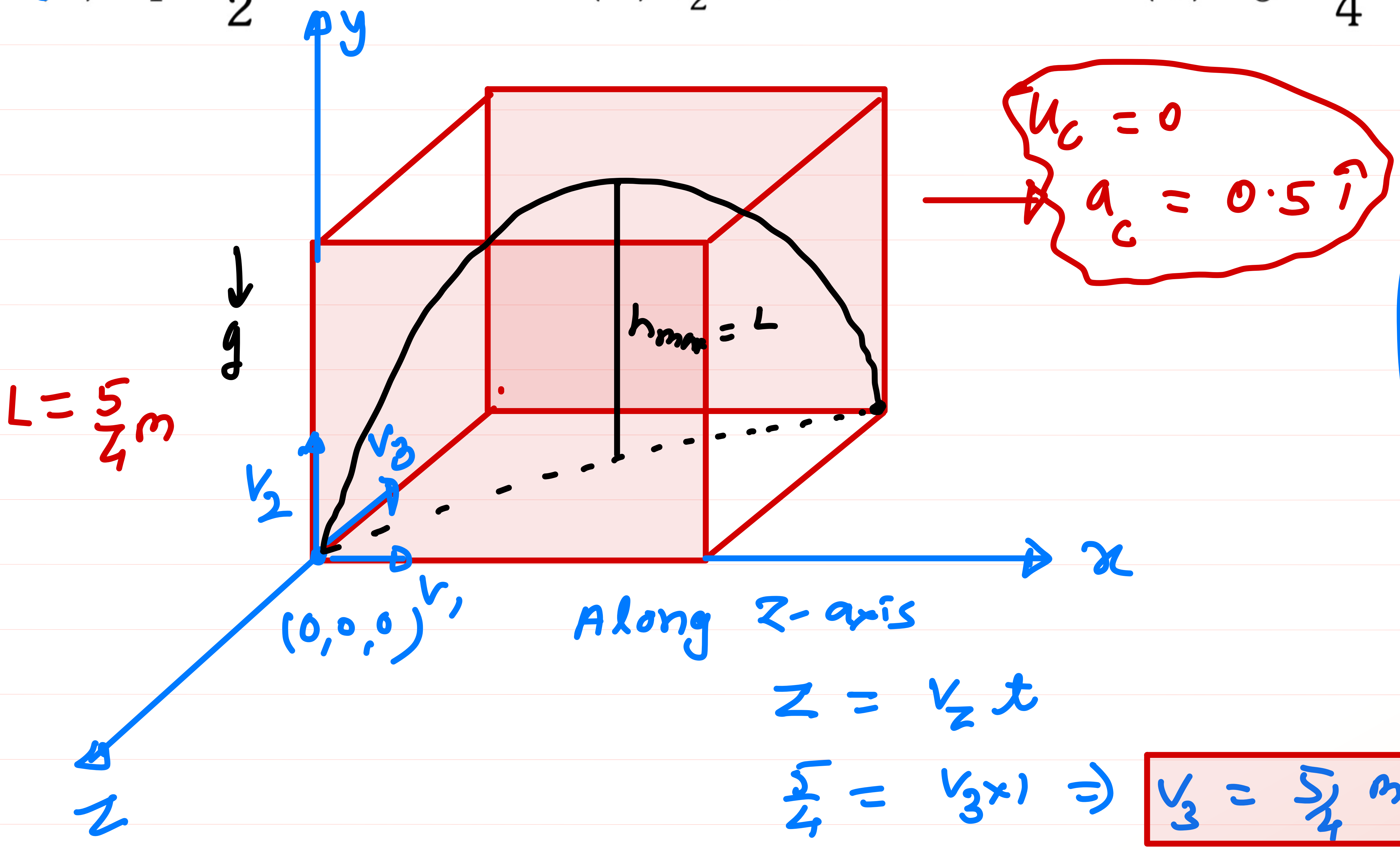
$= 16\hat{j} - 12\hat{i}$ $\Rightarrow V_{WB} = \sqrt{16^2 + 12^2} = 4\sqrt{4^2+3^2}$

$= 4 \times 5 = 20\ m/s$

8. A cubical box dimension L = 5/4 m starts moving with an acceleration $\vec{a} = 0.5\,\text{ms}^{-2}\hat{i}$ from the state of rest. At the same time, a stone is thrown from the origin with velocity $\vec{v} = v_1\hat{i} + v_2\hat{j} - v_3\hat{k}$ with respect to earth. Acceleration due to gravity $\vec{g} = 10\,\text{ms}^{-2}(-\hat{j})$. The stone just touches the roof of box and finally falls at the diagonally opposite point. then

$t = \frac{2\times5}{10} = 1$ sec

(A) $v_1 = \frac{3}{2}$ (B) $v_2 = 5$ (C) $v_3 = \frac{5}{4}$ (D) $v_3 = \frac{5}{2}$



$t = \frac{2u_y}{a_y} = \frac{2\times v_2}{g}$ — (1)

$H_{max} = \frac{u_y^2}{2g} = L = \frac{5}{4}$

$\frac{v_2^2}{2g} = \frac{5}{4} \Rightarrow v_2^2 = \frac{5}{4}\times 2\times10$

$\boxed{v_2 = 5\ \text{m/s}}$

Along z-axis

$z = v_z t$

$\frac{5}{4} = v_3\times1 \Rightarrow \boxed{v_3 = \frac{5}{4}\ \text{m/s}}$

Along x-axis

$x = (u_{sc})_x t + \frac{1}{2}(a_{sc})_x t^2$

$5/4 = (v_1 - 0)\times1 + \frac{1}{2}(0-0.5)\times1^2$

$\frac{5}{4} = v_1 - \frac{1}{4} \Rightarrow v_1 = \frac{6}{4}$

$\boxed{v_1 = \frac{3}{2}}$

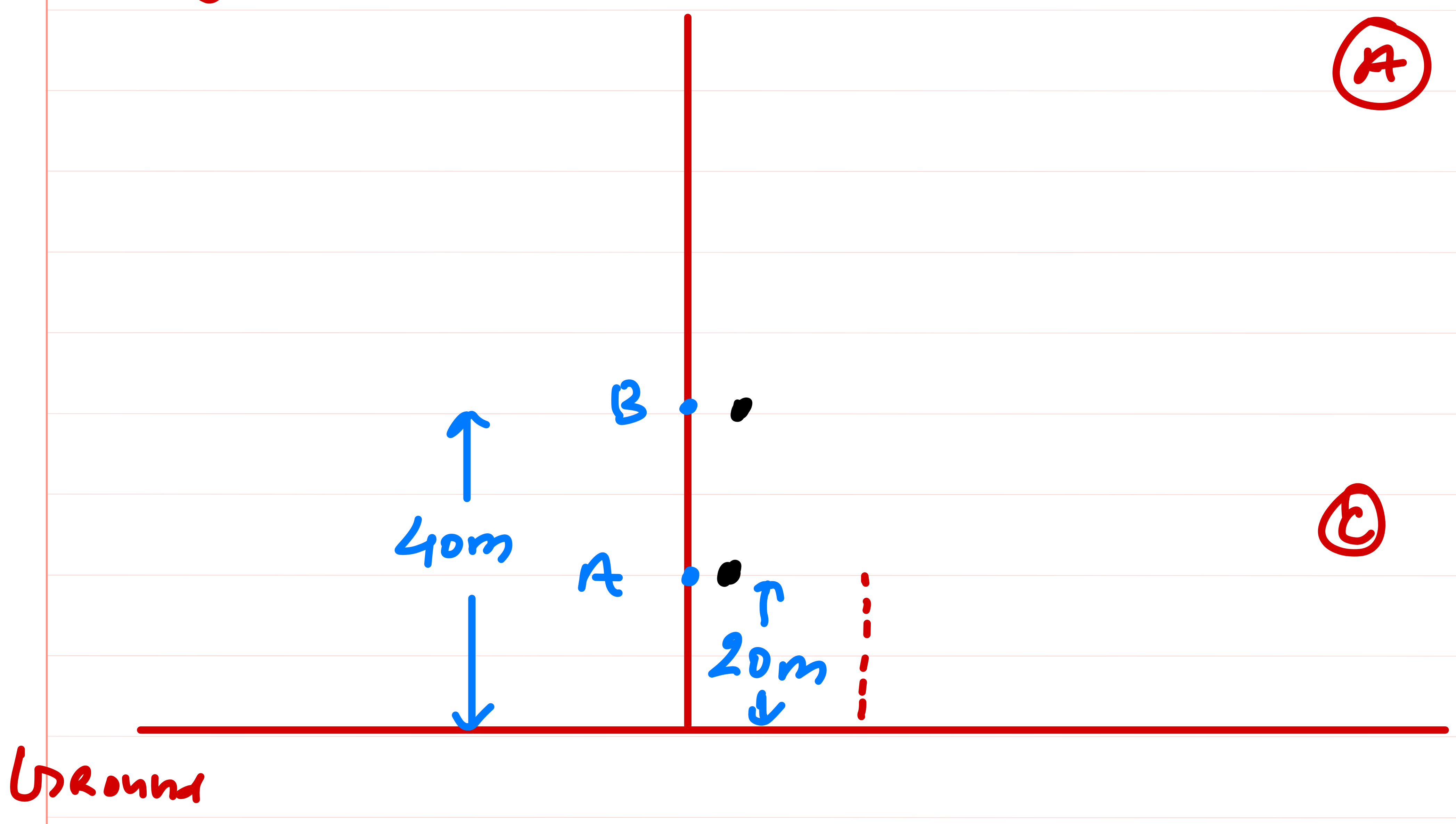
10. A and B are two point on a same vertical line. A is 20m above ground while B is 40m above ground. Two small balls are released from rest, one from A and B each at t=0. Neglect air resistance. All collisions are perfectly inelastic. Choose the correct option(s):

(A) acceleration of A relative to B is zero

(B) acceleration of A relative to B is $9.8 ms^{-2}$

(C) acceleration of A relative to B is zero in $0 \text{ sec} \le t \le 2 \text{ sec}$

(D) acceleration of A relative to B is $9.8 ms^{-2}$ in $2 \text{ sec} \le t \le 2\sqrt{2} \text{ sec}$



(A) $\vec{a}_A = -g\hat{j}$

$\vec{a}_B = -g\hat{j}$

$\vec{a}_{AB} = -g\hat{j} + g\hat{j} = 0$

(C) $t_A = \sqrt{\frac{2h_A}{g}} = \sqrt{\frac{2\times 20}{10}} = 2$ sec

$t_B = \sqrt{\frac{2h_B}{g}} = \sqrt{\frac{2\times 40}{10}} = 2\sqrt{2}$ sec