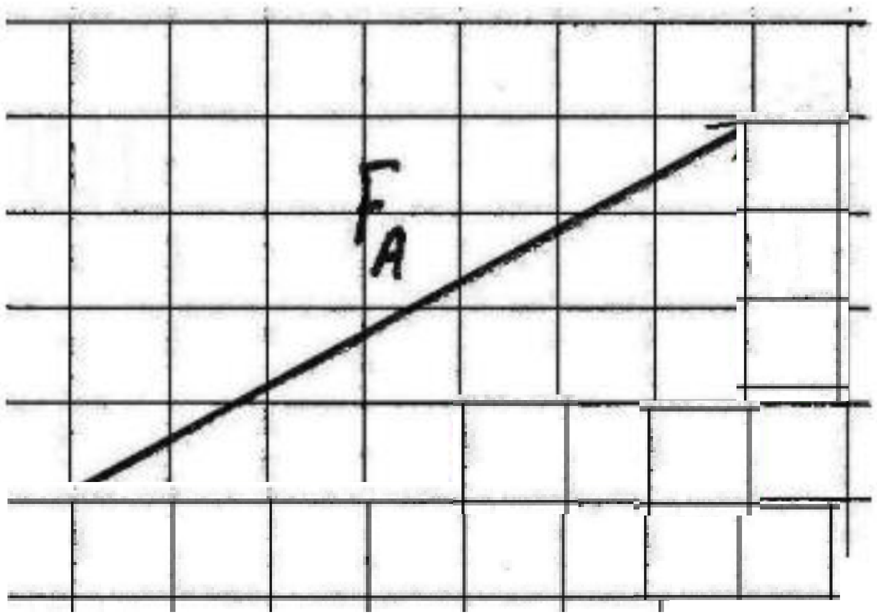
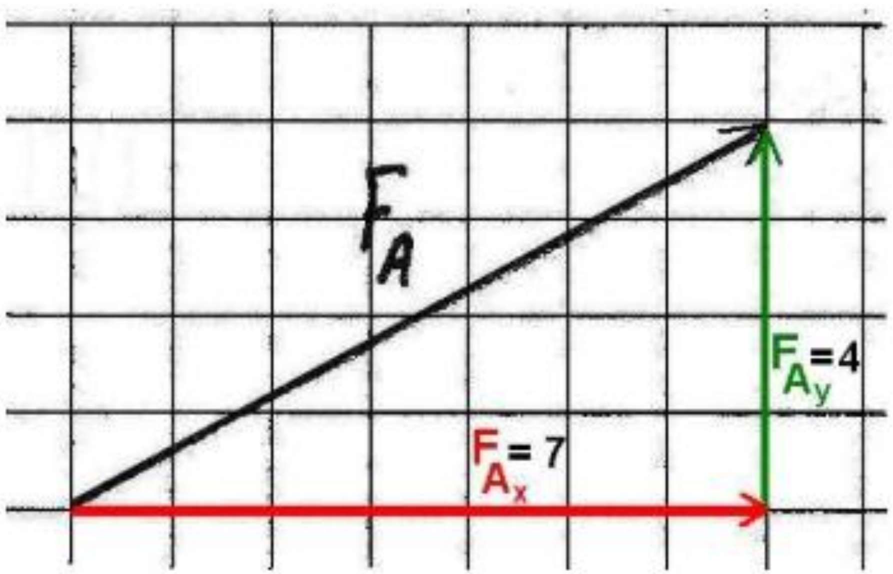
PQ1 Vectors

Q and A

Q1

1.) Graphically break down the following force into its components.





Q2

Given that $F_A = 26.7$ N in the direction: E 18.7° N, find F_{AX} and F_{AY}.

$F_A = 26.7\ N$, E 18.7° N

$F_{Ax} = ?$

$F_{Ay} = ?$

Since $F_{Ax} = F_A \cos \theta$

then $F_{Ax} = 26.7\ N \cos 18.7°$

$F_{Ax} = {}^{+}16.7060\ N$

$F_{Ax} = {}^{+}16.7\ N$

Since $F_{Ay} = F_A \sin \theta$

then $F_{Ay} = 26.7 N \sin 18.7°$

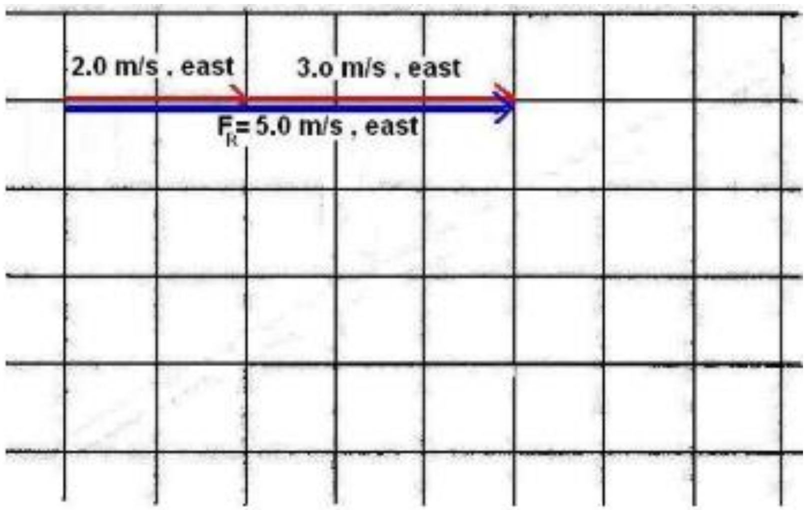
$F_{Ay} = {}^{+}8.56037\ N$

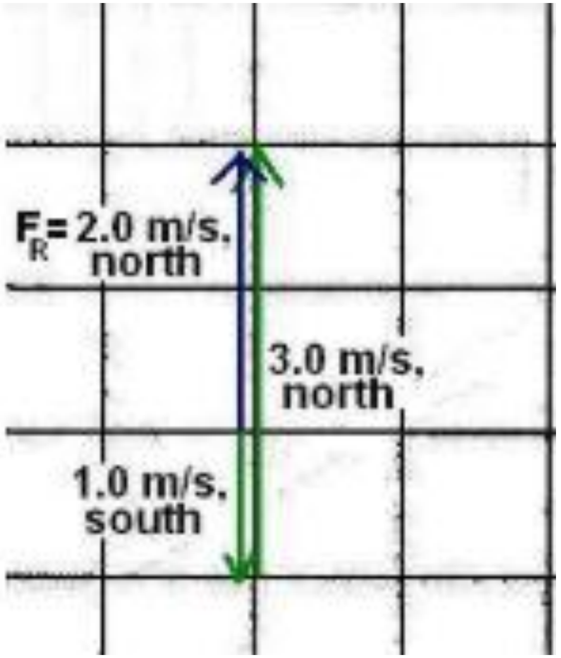
$F_{Ay} = {}^{+}8.56\ N$

Q3

Graphically add the following vectors.

a) A person walks at 2.0 m/s, east relative to a moving sidewalk that is going 3.0 m/s, east.





Graphically add the following vectors.

b) A person swims upstream at 1.0 m/s, south relative to a river going 3.0 m/s, north.

Q4

A 70 N, north force and a 40 N, east force both act on an object.

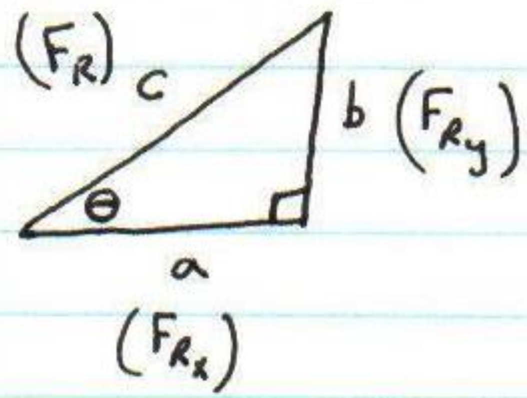
What is the magnitude and direction of the resultant force?

$F_A = 70\,N$, north
$F_B = 40\,N$, east

$F_R = ?$

$F_R^2 = F_{R_x}^2 + F_{R_y}^2$

$c^2 = a^2 + b^2$



$F_R = \sqrt{F_{R_x}^2 + F_{R_y}^2}$

$F_{R_x} = \Sigma F_x = F_{A_x} + F_{B_x}$

$F_{R_x} = 0\,N + {}^{+}40\,N = {}^{+}40\,N$

$F_{R_y} = \Sigma F_y = F_{A_y} + F_{B_y}$

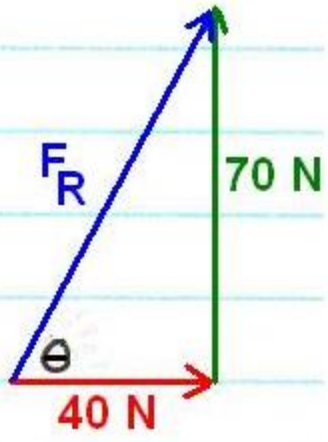
$F_{R_y} = {}^{+}70\,N + 0\,N = {}^{+}70\,N$

Q4 continued

$$F_R = \sqrt{(40N)^2 + (70N)^2}$$

$$F_R = 80.62258\ N$$

$$F_R = 81\ N$$



Since $\tan\theta = \frac{\text{opposite}}{\text{adjacent}} = \frac{F_{R_y}}{F_{R_x}}$

$$\theta = \frac{F_{R_y}}{\tan \cdot F_{R_x}} = \tan^{-1}\frac{F_{R_y}}{F_{R_x}}$$

$$\theta = \tan^{-1}\left(\frac{70N}{40N}\right)$$

$$\theta = 60.255^\circ$$

$$\theta = 60^\circ$$

$$\boxed{F_R = 81N, 60^\circ}$$

Q5

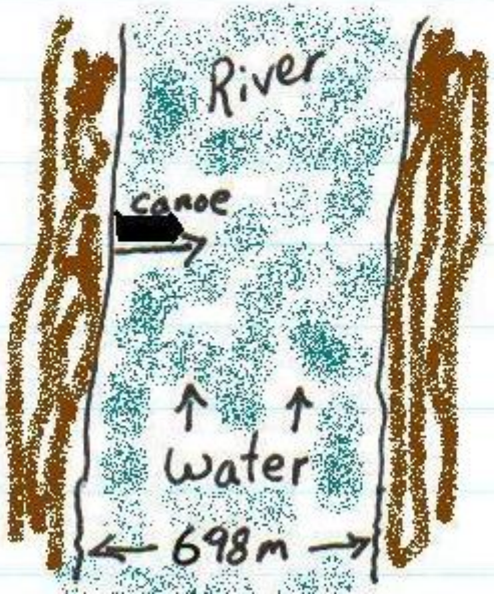
A canoe goes directly across a river at 3.5 m/s.
The water flows at 2.0 m/s and is 698 m across.
a) What is the resultant velocity of the boat?

$V_c = 3.5\ \text{m/s}$

$V_w = 2.0\ \text{m/s}$

$\Delta d_w = 698\ \text{m}$

a) $V_R = ?$



$$V_R = \sqrt{V_{R_x}^2 + V_{R_y}^2}$$

$$V_{R_x} = \Sigma V_x = V_{c_x} + V_{w_x}$$

$$V_{R_x} = 3.5\ \text{m/s} + 0\ \text{m/s} = \underline{\underline{3.5}}\ \text{m/s}$$

$$V_{R_y} = \Sigma V_y = V_{c_y} + V_{w_y}$$

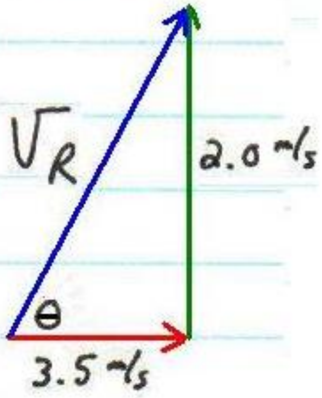
$$V_{R_y} = 0\ \text{m/s} + 2.0\ \text{m/s} = \underline{\underline{2.0}}\ \text{m/s}$$

Q5 continued

$$v_R = \sqrt{(3.5\,m/s)^2 + (2.0\,m/s)^2}$$

$$v_R = 4.0311\,m/s = 4.0\,m/s$$

$$\tan\theta = \frac{v_{Ry}}{v_{Rx}}$$



$$\theta = \tan^{-1}\left(\frac{v_{Ry}}{v_{Rx}}\right)$$

$$\theta = \tan^{-1}\left(\frac{2.0\,m/s}{3.5\,m/s}\right)$$

$$\theta = 29.745^\circ$$

$$\theta = 30^\circ$$

$$\boxed{v_R = 4.0\,m/s,\ 30^\circ}$$

Q6

A 75 km/h wind blows toward 137°, while a plane flys toward 216° at 235 km/h. What is the resultant velocity of the plane?

$$V_w = 75\ km/h,\ 137^\circ$$
$$V_p = 235\ km/h,\ 216^\circ$$

$$V_R = ?$$

$$V_R = \sqrt{V_{R_x}^2 + V_{R_y}^2}$$

$$V_{R_x} = \Sigma V_x = V_{w_x} + V_{p_x}$$

$$V_{R_y} = \Sigma V_y = V_{w_y} + V_{p_y}$$

$$V_{w_x} = V_w \cos\theta$$
$$V_{w_x} = 75\ km/h \cos 137^\circ$$
$$V_{w_x} = -54.8515\ km/h$$
$$V_{w_x} = -55\ km/h$$

$$V_{w_y} = V_w \sin\theta$$
$$V_{w_y} = 51\ km/h$$

$$V_{p_x} = -190\ km/h$$
$$V_{p_y} = -138\ km/h$$

$$V_{R_x} = -55\ km/h + -190\ km/h = -245\ km/h$$

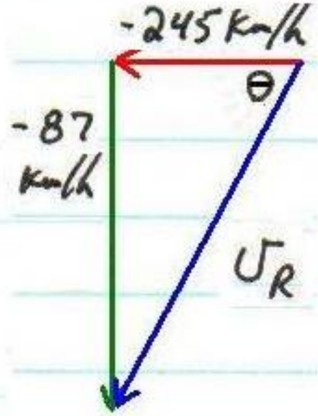
$$V_{R_y} = 51\ km/h + -138\ km/h = -87\ km/h$$

Q6 continued

$$v_R = \sqrt{(-245\ \text{km/h})^2 + (-87\ \text{km/h})^2}$$

$$v_R = 259.988\ \text{km/h}$$

$$v_R = 260\ \text{km/h}$$



$$\tan\theta = \frac{v_{R_y}}{v_{R_x}} = \frac{-87\ \text{km/h}}{-245\ \text{km/h}}$$

$$\theta = 19.550^\circ$$

$$\theta = 20^\circ + 180^\circ$$

$$\boxed{v_R = 260\ \text{km/h},\ 200^\circ}$$

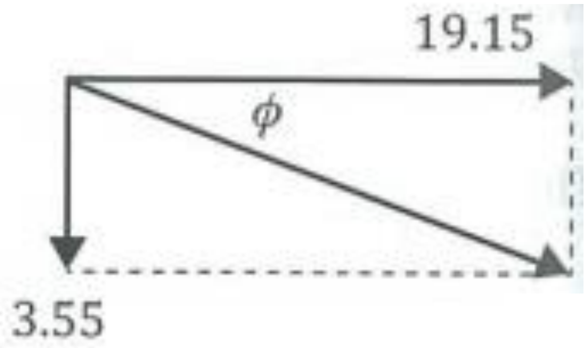
Q7

A stone is catapulted with a velocity of 25 m s^{-1} at an angle of 40° to the horizontal. What is its velocity after 2 s?

Initial velocity: $u_x = 25 \cos 40° = 19.15$ m s^{-1} [4 s.f.];
$u_y = 25 \sin 40° = 16.07$ m s^{-1} [4 s.f.]

$v_x = u_x = 19.15$ m s^{-1}; $v_y = u_y - gt = 16.07 - 9.81 \times 2 = -3.55$ m s^{-1}
[i.e. downwards 3.55 m s^{-1}]

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{19.15^2 + (-3.55)^2} = 19.5 \text{ m s}^{-1} \text{ [3 s.f.]}$$



The direction angle $\phi = \tan^{-1}\left(\frac{3.55}{19.15}\right) = 10.5°$

Answer: The velocity is 19.5 m s^{-1} at an angle of 10.5° below the horizontal.