

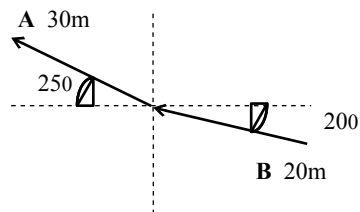
PHY1010 Introductory Physics 2019/20
Tutorial Sheet 01
Vectors

01*. A displacement **D** of 100m from the origin at an angle of 37° above the x-axis is the result of three successive displacements: **d**₁ of 100m along the negative x-axis, **d**₂ of 200m at an angle of 150° above the x-axis, and a displacement **d**₃. Find **d**₃.

[355m, 353.5°]

02*. Find the direction and magnitude of:

- (i) the vector sum **A + B** [10.22m, 145.16°]
- (ii) the vector difference **A - B**, [49.56, 157°] and
- (iii) the vector difference **B - A**. [49.56m, 337°]



03*. A particle undergoes three *successive* displacements in a plane as follows: 4.0m southwest, 5.0m east, 6.0 m in a direction 60° north of east.

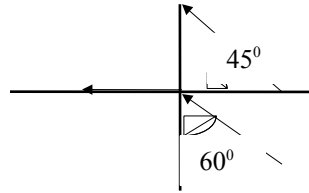
Choose the y-axis pointing north and the x-axis pointing east and find

- i) The components of each displacement,
- ii) The components of the resultant displacement, [5.17m, 2.37m]
- iii) The magnitude and direction of the resultant displacement, [5.69m, 24.63°] and
- iv) Graphically show the approximate displacement of the particle.

04*. The resultant of two force vectors **A** and **B** has a magnitude of 150 N along the y-axis. If the force vector **B** makes an angle of 60° with the positive x-axis, find the magnitude of **B** and the direction of **A**, given that the x-component of **A** is equal to -60 N. [120N, 142.48°]

05*. When displacement **B** is added to displacement **A** the result is a displacement **C** that has components **C**_x = -3.0cm, **C**_y = +6.0cm, and **C**_z = +4.0cm. Displacements **A** and **B** are in the same direction, but the magnitude of **A** is only half that of **B**. Find the components of **A**. [-1, 2, 4/3]

06. The three vectors **A**, **B**, and **C** are as shown. Find the magnitude and direction of a vector **D** which when added to these three vectors will give a zero resultant.



[73.36 m, 260.16°]

07**. A man pulls a box with a force of 70 N along the positive y -axis, while a boy pulls it with a force of 50 N, making an angle of 80° counter clock-wise with the positive y -axis.

- (i) In what direction should a *second boy* apply a force of 60 N so that the box will move along the positive y -axis? *Hint*: two values are possible.
- (ii) Find the magnitude and direction of the force that a *second man* should apply so that the box does not move at all?

(i) [34.85° , 325.15°], (ii) [-112.97 N, -44.39 N]

8** While exploring a cave, a person starts at the entrance and moves the following successive distances. She goes 75.0 m north, 250 m east, 125 m at an angle 30.0° north of west, and 150 m south. Find the resultant displacement from the cave

entrance. Draw a rough diagram. $[R = \sqrt{141.75^2 + (-12.5)^2} = 142.3m]$

PHY1010 Tutorial 1 (2020)

01. $\mathbf{D} = \mathbf{d}_1 + \mathbf{d}_2 + \mathbf{d}_3$

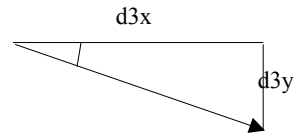
$D_x = d_{1x} + d_{2x} + d_{3x}$ or $100 \cos 37 = -100 + 200 \cos 150 + d_{3x}$ giving

$d_{3x} = 353\text{m}$. $D_y = d_{1y} + d_{2y} + d_{3y}$ or $100 \sin 37 = 0 + 200 \sin 150 + d_{3y}$ giving

$d_{3y} = -40\text{m}$. Hence $d_3 = \sqrt{d_{3x}^2 + d_{3y}^2} = 355\text{m}$ The angle

$\phi = \tan^{-1} \frac{d_{3y}}{d_{3x}} = 6.5^\circ$ below the $+x$ - axis

$= 360 - 6.5 = 353.5^\circ$



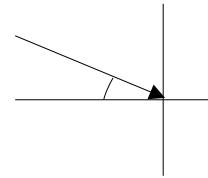
02.

$\mathbf{A} + \mathbf{B} = \frac{\sqrt{-8.39^2 + 5.84^2}}{5.84} = 10.22\text{m}$

$\tan \theta = \frac{8.39}{5.84}$ giving $\theta = 34.84^\circ$
above the $-x$ -axis $= 145.16^\circ$

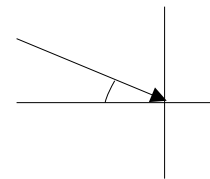
	x	y
A	$30 \cos 155 = -27.19\text{m}$	$30 \sin 155 = 12.68$
B	$20 \cos 340 = 18.80$	$20 \sin 340 = -6.84$
	$R_x = -8.39\text{m}$	$R_y = 5.84\text{m}$

	x	y
A	$30 \cos 155 = -27.19$	$30 \sin 155 = 12.68$
-B	$= -18.80$	$= +6.84$
	$R_x = -45.99$	$R_y = 19.52$



$\mathbf{A} - \mathbf{B} = \frac{\sqrt{-45.99^2 + 19.52^2}}{19.52} = 49.56\text{m}$

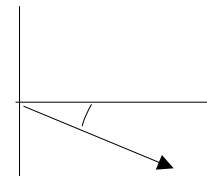
$\tan \theta = \frac{19.52}{45.99}$ giving $\theta = 23^\circ$ above the $-x$ -axis $= 157^\circ$



$\mathbf{B} - \mathbf{A} = \frac{\sqrt{45.99^2 + (-19.52)^2}}{19.52} = 49.56\text{m}$

$[\tan \theta = \frac{19.52}{45.99}$ giving $\theta = 23^\circ$ below the $+x$ -axis $= 337^\circ$

	x	y
-A	$= 27.19$	$= -12.68$
B	$= 18.80$	$= -6.84$
	$R_x = +45.99$	$R_y = -19.52$



03* A particle undergoes three successive displacements in a plane as follows: 4.0m southwest, 5.0m east, 6.0 m in a direction 60° north of east.

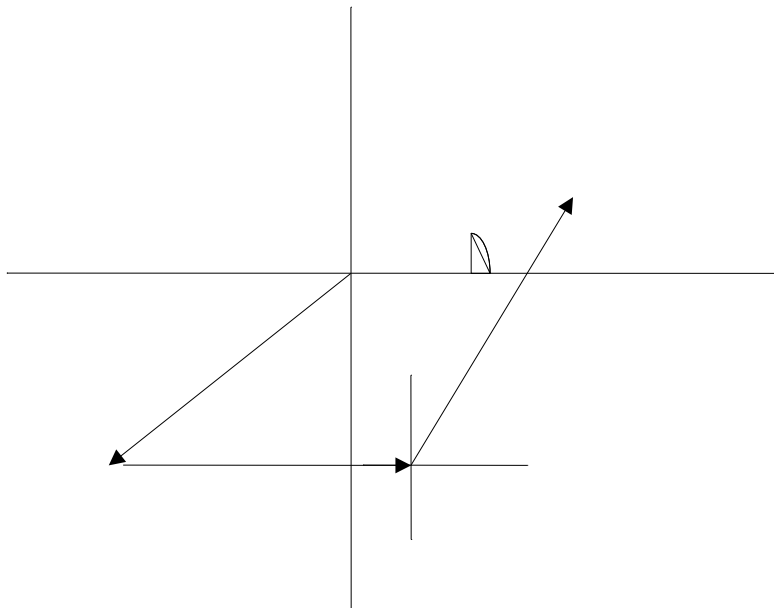
Choose the y -axis pointing north and the x -axis pointing east and find the components of each displacement,

- i) The components of the resultant displacement,
- ii) The magnitude and direction of the resultant displacement, and
- iii) Graphically show the approximate displacement of the particle.

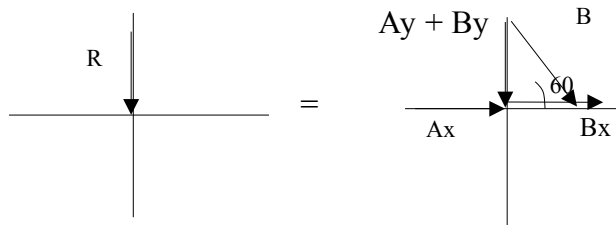
	x	y
A	$4\cos 225 = -2.83$	$4\sin 225 = -2.83$
B	+5	0
C	$6\cos 60 = 3$	$6\sin 60 = 5.20$
	$R_x = 5.17$	$R_y = 2.37$

Resultant $R = \sqrt{5.17^2 + 2.37^2} = 5.69$ m. In the 1st quadrant.

$$\phi = \tan^{-1} \frac{2.37}{5.17} \rightarrow \phi = 24.63^\circ$$



04.



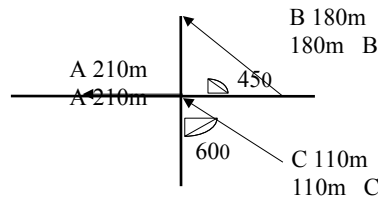
$$A_x + B_x = R_x = 0 = -60 \quad A_y + B_y = R_y = 150 \text{ or } A_y = 150 - B \sin 60 = 150 - 120 \sin 60 = 150 - 103.92 = 46.08$$

Hence $B_x = 60$ or $B \cos 60 = 60$ Hence angle of A = $\tan^{-1}(46.08/60) = 37.52^\circ$ above the negative x-axis = $180 - 37.52 = 142.48^\circ$

05. We have $\mathbf{A} + \mathbf{B} = \mathbf{C}$

	x	y	z
A	= -1	= 2	= 4/3
B	= -2	= 4	= 2(4/3)
C	= -3	= 6	= 4

06. The three vectors \mathbf{A} , \mathbf{B} , and \mathbf{C} are as shown. Find the magnitude and direction of a vector \mathbf{D} which when added to these three vectors will give a zero resultant.

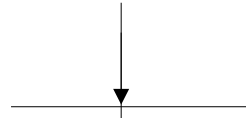
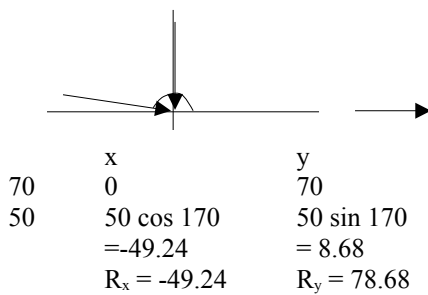


A	-210	0	
B	$180 \cos 45 = 127.28$	$180 \sin 45 = 127.28$	
C	$110 \cos 30 = 95.26$	$110 \sin 30 = -55$	
D	-12.54	-72.28	
R	0	0	

$$R = \sqrt{12.54^2 + 72.28^2} = 73.36 \text{ m} \quad \theta = \tan^{-1} \frac{72.28}{12.54} = 80.16^\circ \text{ in the third quadrant}$$

$$= 180 + 80.16 = 260.16^\circ$$

07.



$$R = \sqrt{(-49.24)^2 + (78.68)^2} = 92.82$$

$$\theta = 180 - 57.96 = 122.04^\circ$$

For the second boy, the x-component of the force should be + 49.24. **Take a force of 60N.**
 $60 \cos \varphi = 49.24$ giving $\varphi = 34.85^\circ$

Or $360 - 34.85 = 325.15^\circ$. In both the cases the box will move along the positive y-axis.

For the second man the force applied will have two values:

i) For 60N at 34.85° for the second boy:

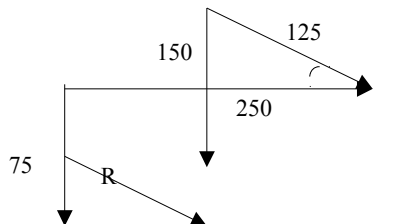
ii) For 60N at 325.15° for the second boy:

	x	y
70	0	70
50	-49.24	8.68
60	49.24	+34.29
M2	F_x	F_y
	$R_x = 0$ or $F_x = 0$	$R_y = 0$ giving
	$F_y = - 112.97\text{N}$.	Along the negative y-axis.

	x	y
70	0	70
50	-49.24	8.68
60	49.24	-34.29
M2	F_x	F_y
	$R_x = 0$ or $F_x = 0$	$R_y = 0$
	giving $F_y = - 44.39\text{N}$.	Along the negative y-axis.

8** While exploring a cave, a person starts at the entrance and moves the following successive distances. She goes 75.0 m north, 250 m east, 125 m at an angle 30.0° north of west, and 150 m south. Find the resultant displacement from the cave

entrance. Draw a rough diagram. $[R = \sqrt{141.75^2 + (-12.5)^2} = 142.3\text{m}]$



We make a table:

vectors	x	y
75	0	75
250	250	0
125	125 cos 150=-108.25	125 sin 150= 62.5

150	0	-150
	$R_x = 141.75$	$R_y = -12.5$

Hence $R = \sqrt{141.75^2 + (-12.5)^2} = 142.3m$.

Angle ϕ that R makes with the x -axis is given by:

$$\tan \phi = \frac{12.5}{141.75} \rightarrow \phi = 5.04^\circ$$

below the $+x$ -axis.

This gives $360 - 5.04 = 354.96^\circ$ w.r.t. the positive x -axis.

