Introduction to Vector Addition and Subtraction - 2013

Last Modified
17/12/2009

Outcomes / Objectives from Motion and Forces in a Gravitational Field Covered in this booklet

- *resolve, add and subtract vectors in one plane*

Materials Required

- Pencil, Ruler, Calculator, Protractor, Additional Paper

Texts

- Heinemann (particularly the CD)
- Stawa

Contents

Introduction

What are vectors?

Numbers in science can be put into two groups called **scalars** and **vectors**. **Scalars** are numbers (quantities) that just have a size and do not have a direction associated with them**. Some examples of scalars are**…

- Temperature
- Mass
- Volume
- Energy
- Power

Vectors are a type of number (quantity) that has both a size and a direction associated with it. **Some examples of vectors are**…

- Velocity
- Acceleration
- Force
- Momentum
- Weight

Scalars obey the normal laws of mathematics. **Vectors** however need to use slightly different mathematical laws that take into account the direction part of the number. This booklet is designed to teach you the new vector mathematical laws so that you can use vectors correctly in physics formulae.

What does a vector look like?

In diagrams and textbooks we show vectors as arrows on a page. The length of the arrow represents the size (magnitude of the number). The direction in which the arrow points, represents the direction of the number.

Example

The direction 160 meters East is drawn as…

How do you add vectors?

If you add together several vectors you will get an answer. The answer is called a resultant or resultant vector. When adding vectors you can add them in any order and you will still get the same answer.

What does the answer look like?

The answer will travel from the start of the first vector to the finish of the last vector. If this is confusing…don't panic. This will be explained more effectively in the section called The Diagrammatic Method.

What are the methods of solving vector problems?

There are 5 methods of solving vector problems. Some methods are used in many situations and others are used only in certain situations. The 5 methods will be called…

N^0	Method Name	When Useful
1	Diagrammatic Method	Y11 & Y12
2	Arithmetic Method.	Y11 & Y12
3	Pythagoras and Sin, Cos, Tan Method (Right Angled Method)	Y11 & Y12
4	Sine Rule and Cosine Rule Method.	Y12
5	Adding Vectors by Components Method.	Y12

Method 1 –Diagrammatic Method

The diagrammatic method requires you to make an accurate scale diagram of the situation. You then measure the result off the diagram.

Advantages

- This technique can be used to combine together two or more vectors.
- It is very visual and easily understood by the drawer and anyone that sees it.

Disadvantages

- The diagram takes some time to draw.
- The answer you measure from the diagram is only accurate if the diagram is accurate.

How do you add vectors together using this method?

The vectors are drawn in pencil. The vectors are drawn (added together) so that the head of the 1st vector arrow touches the tail of the 2nd vector arrow. The head of the 2nd touches the tail of the 3rd and so on.

What does the resultant vector look like?

The resultant vector is from the tail of the first arrow to the head of the last. Another way of saying this is from the start to the finish in a straight line. See the example below to get a better idea.

Example

Add together the following vectors

5.00 m West
8.50 m North East
3.00 m South
3.00 m East

Answer measured from diagram is 5.00 m North (arctan 4/3) ^{0} East

Notice that the vectors have been…

- Added such that the head of the first touches the tail of the next…etc
- The resultant vector is from the tail of the first to the head of the last (start to finish)
- We could have added the vectors together in a different order and still got the same answer.

Activity 1

1. Try the example question again, but add together the vectors in a different order and see if you get the same result. (You should!)

(Note – there is no answer provided at back of booklet for this activity. There are too many variations in the order of adding vectors).

Method 2 – Arithmetic Method

When should you use the arithmetic method?

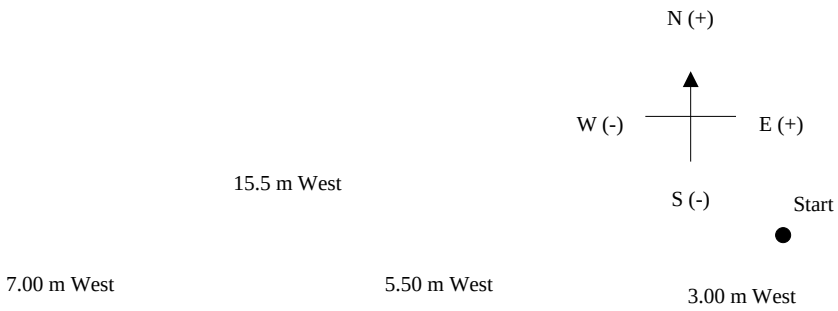
When all of the vectors to be added are in one dimension (a straight line) then you can just add the numbers using a sign convention.

Example

Add together the following vectors.

3.0 m West
5.5 m West
7.0 m West

Sketch the situation (not necessarily to scale) to get your mind in the picture.



Arithmetic method

State the sign convention.
West = - ve
East = + ve

Add the vectors using a + or – sign for direction

Resultant = (-7.00) + (-5.50) + (-3.00)
Resultant = -15.5

Convert answer back to directions in words
Resultant = **15.5 m West**

Does you mathematical answer match the answer predicted by the diagram? If not check the diagram and the mathematics until agreement can be found.

Note: - no matter which vector addition method you decide to use to solve a question, you should ALWAYS sketch the situation using vector arrows.

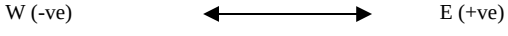
What is a sign convention?

Notice that in the mathematics of the previous example we have used a sign convention. A sign convention is the way that mathematics deals with different (opposite) directions in one dimension. An example of this is setting all vectors with a forward direction as positive (+) and all vectors with a backwards direction as negative (-). We recommend you use a sign convention in all your one dimensional vector problems. You should state your sign convention on your diagram…

Examples of sign conventions written on diagrams

- North = +ve and South = -ve

- East = +ve and West = -ve



- Up = +ve and Down = -ve

When should you NOT use the arithmetic method?

Do not use the arithmetic method in 2 or 3 dimensional problems (when the vectors you are adding are not in the same direction / dimension / along the same line).

Examples

OK to use	Not OK to use
North + North	North + East
North + South	South + South West
Up + Down Etc	Up + Left Etc
I.e. all vectors are along the same line	I.e. all vectors are not along the same line and so not suitable for the arithmetic method.

Activity 2

#act2ans

1. Add together the following vectors

27 m up
7 m up
10 m down
15 m down

a) Is it appropriate to add the following vectors using the arithmetic method? Why?

_____

b) Does it matter in which order you add the vectors? _____

c) Sketch a diagram of the situation.

d) Draw the sign convention on the diagram?

e) Do the calculation using the sign convention.

f) Does the sketch approximately agree with the answer?

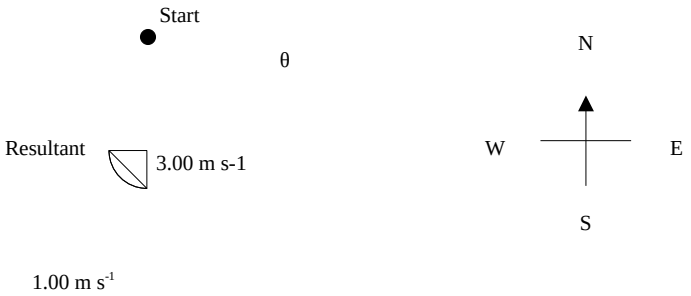
Method 3 - Pythagoras and Sin, Cos, Tan Method

When do you use this method?

When you are adding exactly two vectors together and they are at right angles to each other.

Example

A person is swimming south along a beach at 3 m s^{-1}. At the same time there is a rip (ocean current) pushing them west a 1 m s^{-1}. What is the person's resultant velocity and direction?



Find Pythagoras to find the length of the resultant vector

$R^2 = 3^2 + 1^2$
$R^2 = 10$
$R = 3.16$ m s^{-1} *Update the diagram*

Find the direction using trig (tan).

$\tan \theta = 1/3$
$\theta = \arctan (1/3)$ also known as $\theta = \tan^{-1} (1/3)$
$\theta = 18.4^{0}$ *Update the diagram*

Final answer

R = 3.16 m s^{-1} South 18.4^{0} West

IMPORTANT note on directions

When stating the direction of the resultant vector it is best to …

1. State the direction of the first vector added.
2. State the angle formed between the first vector and the resultant vector.
3. State the direction in which you move to get from the first vector to the resultant vector.

When should you NOT use Pythagoras and sin, cos, tan method?

When the two vectors are not at right angles to each other or there are more than two vectors to be added.

Activity 3

#act3ans

1. A aeroplane is travelling at 120 km/h East. The aircraft is also experiencing a crosswind from the North at a velocity of 35 km/h. What is the resultant velocity of the aircraft?

a) Convert the velocities from km/h to m/s.

b) Is it appropriate to use the sin, cos, tan, pythagorus method? Why?

_____

c) Draw a diagram of the situation (2 ways are possible)

d) Do the calculation

e) Does you diagram roughly match you answer?

_____

f) Did you need a sign convention? Why?

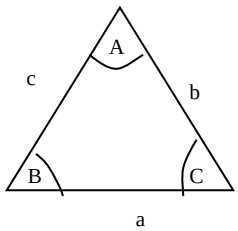
_____

_____

Method 4 - Sine Rule and Cosine Rule

When should you use sine rule and cosine rule?

When you have to add two vectors together in 2 dimension (in a plane, not in a line) and they are not at right angles to each other.



What are Sine Rule and Cosine Rule

Cosine Rule

$$a^2 = b^2 + c^2 - 2bc \cos(A)$$

Sine Rule – Don't use sin rule to calculate angles if you can avoid it (ambiguous case)

$$\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$$

How do you know which rule (cosine or sin) to use?

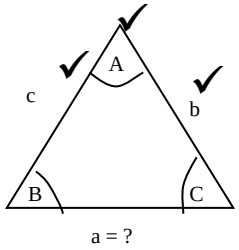
Sketch the triangle and mark on all known information.

Use Cosine rule when you …

- know 2 sides and an included angle and you wish to find the remaining side

or

- you know 3 sides and you wish to find any one of the angles



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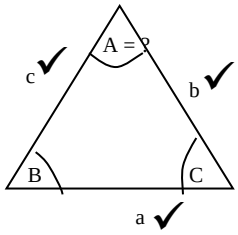
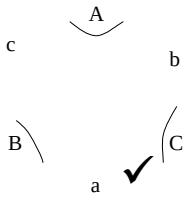


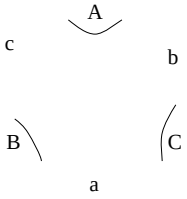
Use Sin rule when you …

- know 2 sides and a non - included angle and you wish to find another angle. (this can lead to multiple answers – known mathematically as the ambiguous case)

or

- know 2 angles and a non - included side and you wish to find another side.

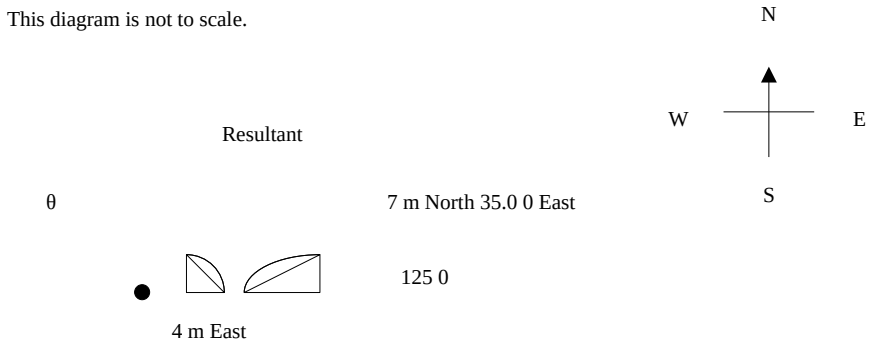




Ambiguous case

Example

A boat travels 4.00 m East. The boat now tacks and travels 7 m North 35.0 ^{0} East. Calculate the total displacement (distance from start to finish in a straight line) of the boat.



Decide whether to use sin rule or cosine rule.

This triangle has 2 sides and an included angle known, so we will use cosine rule.

$a^2 = b^2 + c^2 - 2bc \cos A$

$R^2 = 4^2 + 7^2 - 2x4x7 \cos(125)$

R = 9.85 m *Update the diagram*

To determine the angle between the first vector and the resultant vector we need sin rule.

$$\frac{\sin\theta}{7} = \frac{\sin(125)}{9.85}$$

$$\theta = \arcsin\left(\frac{7x\sin(125)}{9.85}\right)$$

θ = 35.6 ^{0} Update diagram

Cos rule would have been a better choice here as Sin Rule contains the ambiguous case. Try as an exercise reworking the numbers using Cos Rule to get the same answer of the angle.

Final Answer

9.85 m East 35.6 ^{0} North

When should you NOT use sine rule and cosine rule?

When there are more than two vectors to be combined together.

Activity 4

#act4ans

1. What is the resultant vector of 10 m South and 20 m North 50^0 East?

a) Are these vectors in S.I. units? Explain.

_____

b) Is it appropriate to use sine rule and or cosine rule? Why?

_____

c) Draw a diagram of the situation (2 ways are possible)

d) Do the calculation

e) Does your diagram roughly match your answer?

_____

f) Did you need a sign convention? Why?

_____

_____

Method 5 – Adding Vectors by Components

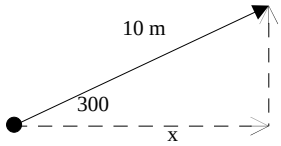
When do you use the components method?

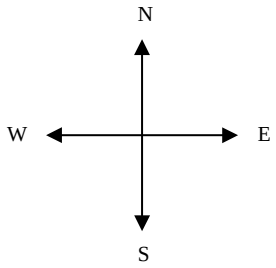
Adding (resolution) of vectors by using components is used when there are 3 or more vectors to be added together. This method can be used in any of the previously mentioned situations (method 1 – method 4). It is a general method that can be quite slow, but is extremely powerful.

What are components?

A component is a part of a vector in a particular direction. This is best taught by using an example.

Example
What is the easterly component of the vector 10 m North 60^0 East?





In other words how long is this vector when measured along the easterly line?

The component is calculated using the trigonometry of right angles triangles

$$\cos\theta = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

$$\cos 30^0 = \frac{x}{10}$$

$$x = 10 \cos 30^0$$

x = 8.66 m East

Activity 5

#act5ans

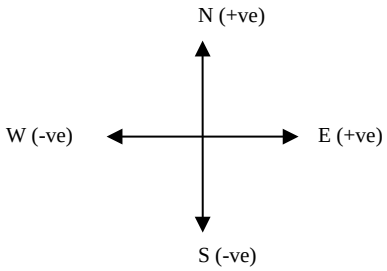
1. What is the component in a northerly direction of the vector 10 m North 60^0 East?

2. A telephone pole is leaning over at an angle of 70^0 to the horizontal as a result of termite damage. The telephone pole has a length of 3.5 m.

a) What is the length of the pole as measured along the ground (horizontal component)?

b) What is the height of the pole (vertical component)?

Steps to the adding vectors by components process



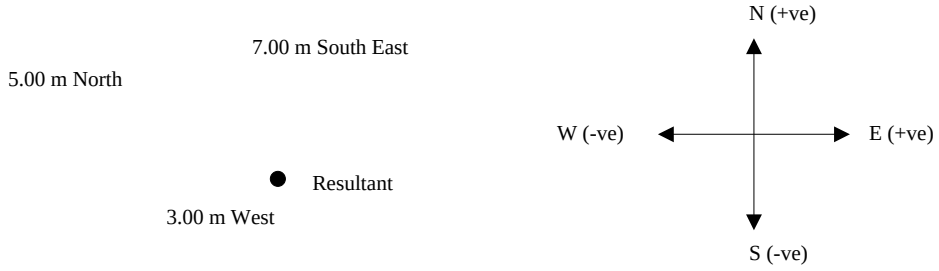
1. Set up a sign convention E.g. North = +ve
   South = - ve
   East = + ve
   West = - ve
2. Split each vector into two parts, an east/west part (x - part) and a north/south part (y - part). These parts are called components of the original vectors.
3. Combine (Add) the components that are all going in the same dimension (line or direction) to produce resultant vectors for each dimension (usually one in the x direction and one in the y direction).
4. Combine the x -resultant and the y - resultant created in step 3 using and Sin, Cos, Tan and Pythagoras rule to produce the final answer.

Example

Combine the following vectors.

3.00 m West
5.00 m North
7.00 m South East

Step 1



Step 2

Vector	**East / West Component (x – axis)**	**North / South Component (y – axis)**
← 3 m West	-3.00	0
↑ 5 m North	0	+ 5.00
↘ 7 m South East	+ 7.00 Cos (45^0) (+4.9497 m)	- 7.00 Sin (45^0) (-4.9497 m)
Total of that dimension (Step 3)	**+ 1.9497**	**+ 0.0503**

Step 4

Size

$R^2 = 1.9497^2 + 0.0503^2$

R = 1.95 m

Direction

$\text{Tan } \theta = \frac{0.0503}{1.9497}$

$\theta = \text{Arctan } (\frac{0.0503}{1.9497})$

$\theta = 1.48^0$

Answer

R = 1.95 m East 1.48^0 North

Activity 6

#act6ans

1. Combine the following three displacements

11.0 m South

7.00 m North West

3.00 m West

a) Is it appropriate to use the components method? Why?

_____

b) Draw a diagram of the situation (there are 6 ways possible) (best to do it in the order provided since it will be easier to check it against the answer provided at the back of the booklet.)

c) Set the sign convention on the diagram.

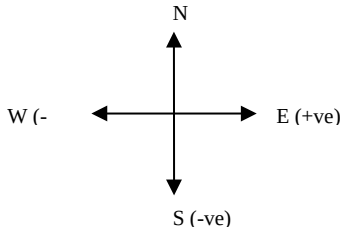
d) Calculate the x and y components of each vector and add them together to find the x total and the y total. It is easiest to do this in a table

Questions continued over the page

e) Combine the x and y totals to find the resultant vector (magnitude and direction).

f) Does your diagram match you answer? (It should)

_____



Vector Subtraction

What is vector subtraction

Strictly speaking there is no such thing as vector subtraction, there is just vector addition. When you subtract a vectors you actually adding a negative vector. A negative vector has the same size as a positive one but has the opposite direction to the word direction supplied.

E.g. -4 m West looks like 

So -4 m West is actually 4 m East

E.g.

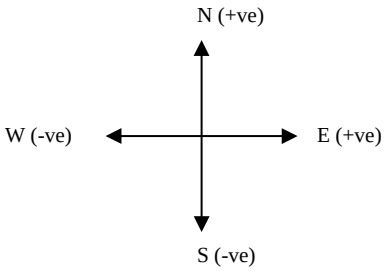
- 4.00 m East	=	+ 4.00 m West
-7.00 m North	=	+ 7.00 m South
-2.39 m North West	=	+ 2.39 m South East.

Put another way…

When adding a negative vector to other vectors it is best to change the negative vector to its positive equivalent and then add the positive equivalent.

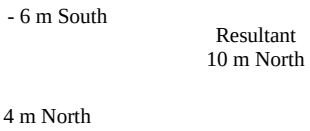
Example

From 4 m North subtract 6 m South.
= 4 m North **- 6 m South**
= (+ 4 m North) + (**- 6 m South)**



This is the same as…
= (+4 m North) + (**+6 m North)**

Both look identical in diagram. See below.



Summary
When adding a negative vector it is better to add its positive equivalent instead.

Activity 7

#act7ans

1. Draw diagrams of the following vector subtractions.

a) 3 m North - 5 m South

b) 2 m West - 4 m East

c) 9 m Up - 4 m Right

d) 5 m East - 5 m South

e) 7 m left - 2 m left

General Approach to Solving Vector Questions

The steps to follow…

1. READ the question and identify that it is a vector question. If it is a vector question you will remember to use one of the 5 methods that have been mentioned in this booklet.

2. DRAW a neat (but not measured) DIAGRAM of the situation.

3. DRAW the VECTORS to be added or used in the calculation on the diagram.

4. SELECT the physics formula you will be using to answer the question

5. RE – DRAW the vectors according to the formula you are using.

6. SELECT one of the 5 vector METHODs (not usually Method 1 - Diagrammatic) and solve.

Example A bullet traveling at 20.0 m s^{-1} North East, Strikes a wall and ricochets. The bullet continues after the collision with the wall at a velocity of 20.0 m s^{-1} North West. What is the change in velocity of the bullet?

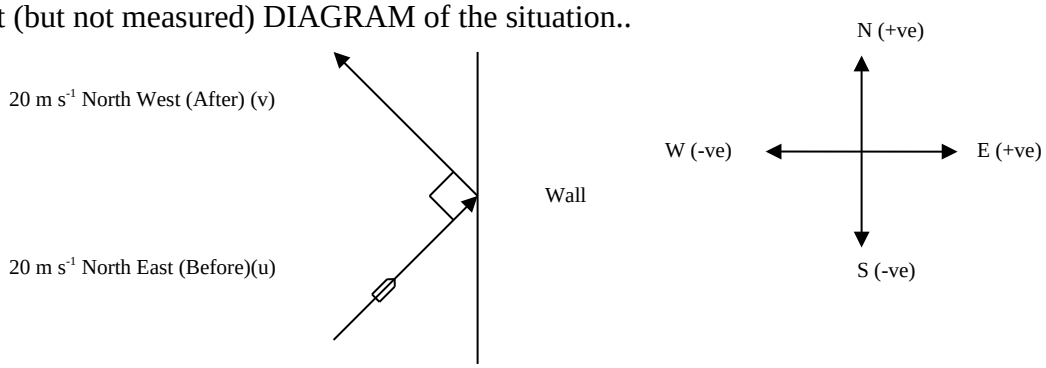
(note :- Δv = $v - u$)

Following the Steps

1. READ the question and identify that it is a vector question. If it is a vector question you will remember to use one of the 5 methods that have been mentioned in this booklet

   This is a vector question because it involves adding / subtracting two vectors

2. DRAW a neat (but not measured) DIAGRAM of the situation..



3. DRAW the VECTORS to be added or used in the calculation on the diagram.

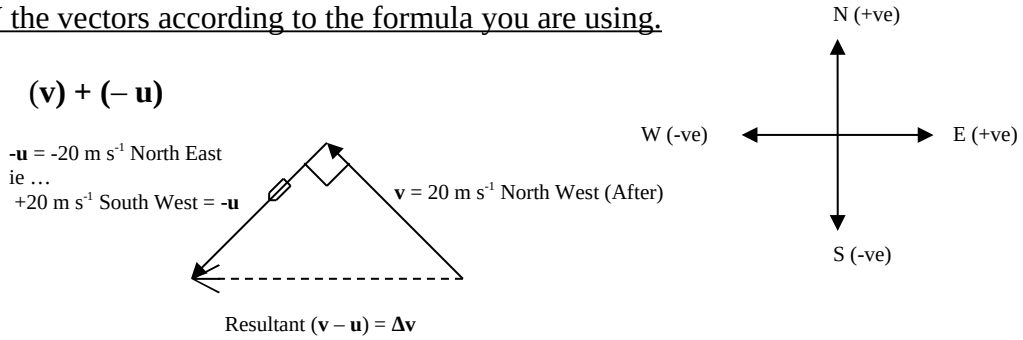
   Already done

4. SELECT the physics formula you will be using to answer the question

   $\Delta \mathbf{v}$ = $\mathbf{v} - \mathbf{u}$

5. <u>RE – DRAW the vectors according to the formula you are using.</u>

   $\Delta \mathbf{v}$ = $\mathbf{(v) + (-u)}$



6. SELECT one of the 5 vector METHODs (not usually Method 1 - Diagrammatic) and solve.

   Selecting Vector Method Number 3 – Sin, Cos, Tan and Pythagoras because the question has a right angle between vectors.

   R^2 = $a^2 + b^2$

   R^2 = $20^2 + 20^2$

   R^2 = 800

   R = 28.3 m s^{-1}

   The direction can be worked out by carful inspection.

   Final Answer = 28.3 m s^{-1} West

Activity 8

#act8ans

1. A car travelling at 15.0 m/s North, turns and travels at 20.0 m/s West. What is the change in velocity?

a) What is the most appropriate method to use here?

b) Draw a diagram of the situation

c) What is the correct formula to use?

d) Redraw the diagram according to the formula

e) Calculate the answer.

f) Do your diagram and calculation match?

Vector Techniques – Booklet Review

Please supply you own paper to answer these questions where appropriate.

#reviewans

1. What writing tool do you use to draw vector diagrams?

   _____

2. Which of the vector methods discussed in this booklet use sign conventions.

   _____

   _____

3. Add together the following vectors using the diagrammatic method.

   10 m Up
   4 m Right
   7 m Down

   ---

4. Add together the following vectors

   4 m s^{-1} North East
   5 m s^{-1} North East
   7 m s^{-1} South West
   6 m s^{-1} South West

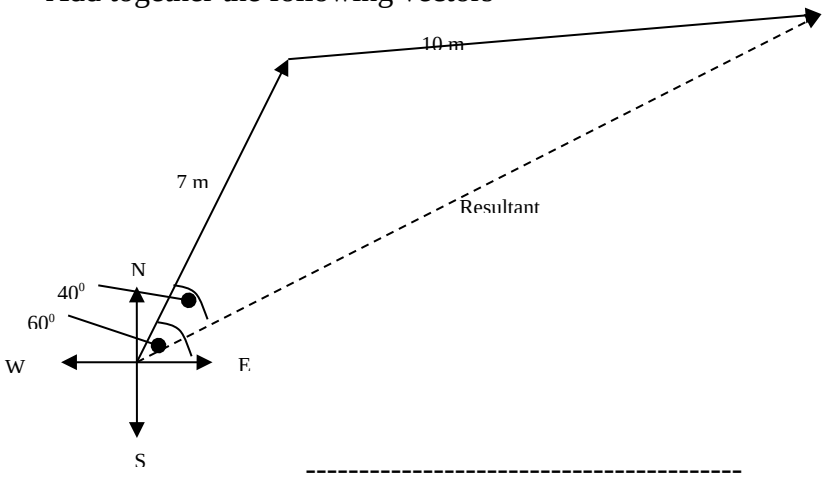
   ---

5. Add together the following vectors

   10 km Left
   7 km Up

   ---

6. Add together the following vectors



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7. Add together the following vectors

20 N West
14 N North
5 N North 60^0 East

What Do We Do Now? (W^2D^2N) - Additional Problems

Year 11

Heinemann 2AB → Book - Chapter 3.1&3.2	p86 - 96.

Year 12

Heinemann 3AB →CD - Extra Information – Analysing Motion Vector and FBDiagrams (Chapter 1.4)	p416 - 421
Stawa Set 1	p18 - 20

Activities Answers

Activity 2 Solution

#act2

Question

1. Add together the following vectors

27 m up
7 m up
10 m down
15 m down

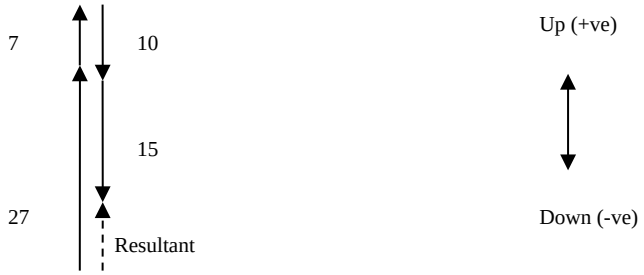
Answer

a) Is it appropriate to add the following vectors using the arithmetic method? Why?

Yes These vectors are all along the same line (up / down) so we can use the arithmetic method.

b) Does it mater in which order you add the vectors? No. You will still get the came result because vector addition is commutative

c) Draw a sketch of the situation.



d) Draw the sign convention on the diagram?

e) Do the calculation using the sign convention.

Using the sign convention and the arithmetic method we get…

= (+27.0)+ (+7.00)+ (-10.0) + (-15.0)
= +9.00 m
= 9.00 m Up.

f) Does the sketch approximately agree with the answer?

Yes

Activity 3 Solutions

#act3

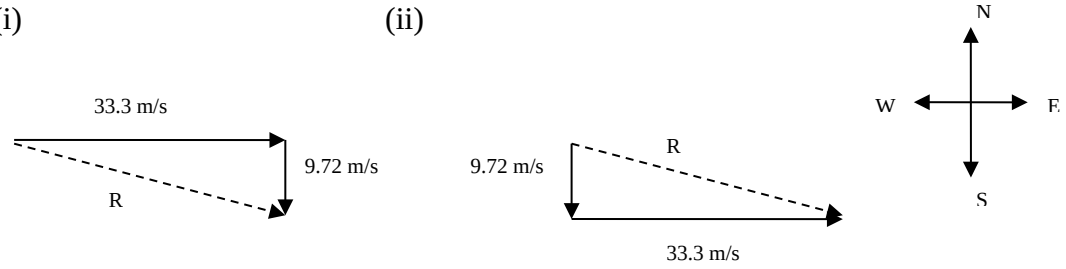
1. A aeroplane is travelling at 120 km/h East. The aircraft is also experiencing a crosswind from the North at a velocity of 35 km/h. What is the resultant velocity of the aircraft?

a) Convert the velocities from km/h to m/s.
120 km/h = 33.3m/s
35 km/h = 9.72 m/s.

b) Is it appropriate to use the sin, cos, tan, pythagorus method? Why?
Yes, because the two vectors being combined are at right angles to each other.

c) Draw a diagram of the situation (2 ways are possible)

(i) (ii)



d) Do the calculation

Magnitude

$R = \sqrt{(33.3^2 + 9.72^2)}$

$R = 34.7$ *m/s*

Direction (based on diagram ii)

Angle = Arctan (33.3/9.72)

$Angle = 73.7^0$

Final Answer = 34.7 m/s South 73.7^0 East

e) Does you diagram roughly match you answer?
Yes

f) Did you need a sign convention? Why?
No. The numbers are not in one dimension.

Activity 4 Solutions

#act4

(corrected – ed 10-2-2009)

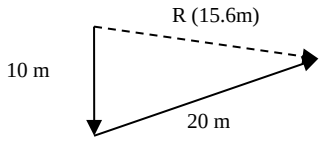
1. What is the resultant vector of 10 m South and 20 m North 50^0 East?

a) Are these vectors in S.I. units? Explain.
Yes. m is the S.I. unit of displacement

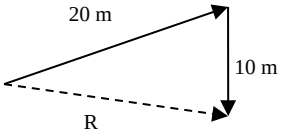
b) Is it appropriate to use sine rule and / or cos rule? Why?
Yes, because there are exactly two vectors and they are not at right angles to each other

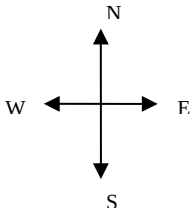
c) Draw a diagram of the situation (2 ways are possible)

(i)



(ii)





d) Do the calculation
This calculation is based on the first diagram.
Use Cos rule to find magnitude of R

$R^2 = 10^2 + 20^2 - (2*10*20 \text{ Cos } (50^0))$
$\boldsymbol{R = 15.6 \text{ m}}$

Use Cosine rule to find angle (not the sin rule)
Note - don't use Sine rule if you can avoid it as this can provide two alternative solutions, (100.5^0 and 79.5^0) but only one is correct. Sine rule leads to ambiguity.

$20^2 = 10^2 + 15.6^2 - (2*10*15.6 \text{ Cos } (\theta^0))$
$\text{ArcCos } ((20^2 - 10^2 - 15.6^2)/(-2 \text{ x } 10\text{x } 15.6)) = \theta^0$
$\boldsymbol{\theta^0 = 100.5^0}$

Final Answer = 15.6 m South 100.5^0 East

NOTE :- If you use sin rule you can obtain 2 possible answers(the ambiguous case) of 100.5^0 or 79.5^0. Only 100.5^0 is correct. This is why Cos rule is better.

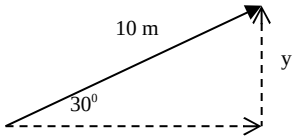
e) Does you diagram roughly match you answer?
Yes

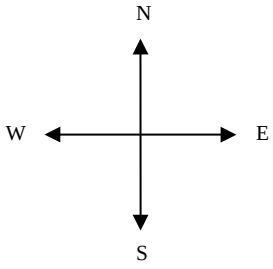
f) Did you need a sign convention? Why?
No, the vectors were not in one dimension

Activity 5 Solutions

#act5

1. What is the component in a northerly direction of the vector 10 m North 60^0 East?





Sin θ = opposite
hypotenuse

Sin 30^0 = y
10

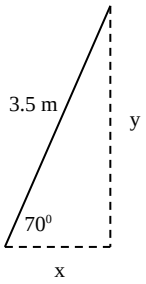
y = 10 Sin 30^0

y = 5 m North

2. A telephone pole is leaning over at an angle of 70^0 to the horizontal as a result of termite damage. The telephone pole has a length of 3.5 m.

a) What is the length of the pole as measured along the ground (horizontal component)?

Cos θ = Adjacent
Hypotenuse



Cos 70^0 = x
3.5

x = 3.5 Cos 70^0

x = 1.20 m Horizontally

b) What is the height of the pole (vertical component)?

Sin θ = Opposite
Hypotenuse

Sin 70^0 = y
3.5

y = 3.5 Sin 70^0

y = 3.29 m Vertically

Activity 6 Solutions

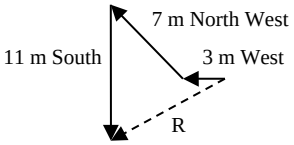
#act6

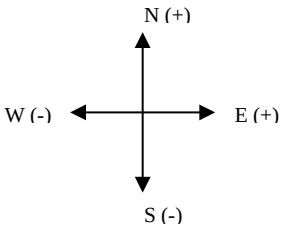
1. Combine the following three displacements…

11 m South
7 m North West
3 m West

a) Is it appropriate to use the components method? Why?
*There are three or more vectors being added together.*_____

b) Draw a diagram of the situation (there are 6 ways possible) (best to do it in the order provided since it will be easier to check it against the answer provided at the back of the booklet.)





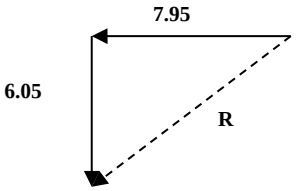
c) Set the sign convention on the diagram.
d) Calculate the x and y components of each vector and add them together to find the x total and the y total. It is easiest to do this in a table

Original Vector	x - component (East/West)	y - component (North/South)
11 m South	0	-11 m
7 m North West	7 m Cos (45) = -4.95m	7 m Sin (45) = +4.95m
3 m West	-3 m	0
Total	**-7.95**	**-6.05**

e) Combine the x and y totals to find the resultant vector (magnitude and direction).

$R = \sqrt{(-7.95^2 + -6.05^2)}$
$R = 9.99$ m

Angle = Arctan (7.95 / 6.05)
Angle = 52.7^0



Final Answer = 9.99 m South 52.7^0 West

f) Does your diagram match you answer (It should)?
_____

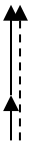
Activity 7 Solutions

#act7

(corrected – ed 2-2-2007)

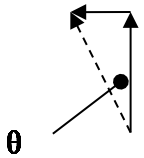
1. Draw diagrams of the following vector subtractions.

a) 3 m North - 5 m South
3 m North + 5 m North
8 m North



b) 2 m West - 4 m East
2 m West + 4 m West
6 m West

c) 9 m Up - 4 m Right
9 m Up + 4 m Left

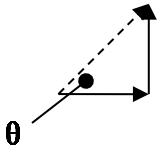


$R^2 = 9^2 + 4^2$
R = 9.85 m

Tan θ = (4/9)
θ = ArcTan (4/9)
θ = 24.0 ^{0}

Final Answer = 9.85 m Up 24.0 ^{0} Left

d) 5 m East - 5 m South
5 m East + 5 m North

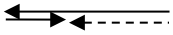


$R^2 = 5^2 + 5^2$
R = 7.07 m

Tan θ = (5/5)
θ = ArcTan (1)
θ = 45.0 ^{0}

Final Answer = 7.07 m North 45.0 ^{0} East

e) 7 m left - 2 m left
7 m left + 2 m right
5 m left



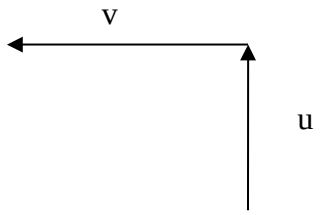
Activity 8 Answer

#act8

1. A car travelling at 15 m/s North, turns and travels at 20 m/s West. What is the change in velocity?

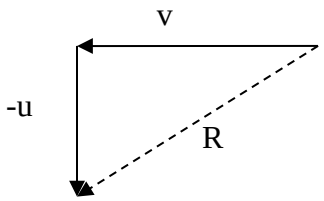
a) What is the most appropriate method to use here?
Sin, Cos, Tan, Pythagoras Method

b) Draw a diagram of the situation



c) What is the correct formula to use?
$\Delta \boldsymbol{v} = \boldsymbol{v} - \boldsymbol{u}$

d) Redraw the diagram according to the formula



e) Calculate the answer.

$R = \sqrt{(20^2 + 15^2)}$
$R = 25$ *m/s*

Direction
Angle = Arctan (20/15)
$Angle = 53.1^0$

Final Answer = 25 m/s South $\boldsymbol{53.1^0}$ ***West***

f) Do your diagram and calculation match?
Yes

Booklet Review Answers

#review

1. A sharp lead pencil.

2. Methods 2 (arithmetic method) and method 5 (components method)

3. 5 m Up 53.13^0 Right

4. 4 m s^{-1} South West.

5. 1.22×10^4 m Up 55^0 Left (S.I. Units)

6. 14.3 m North 70.0^0 East
   (angles = 40.0^0, 26.7^0, 113^0) (opp sides = 10.0m, 7.00m, 14.3m)

7. 22.75 N North 43.5^0 West (checked 10/2/2009 and was ok - ed)